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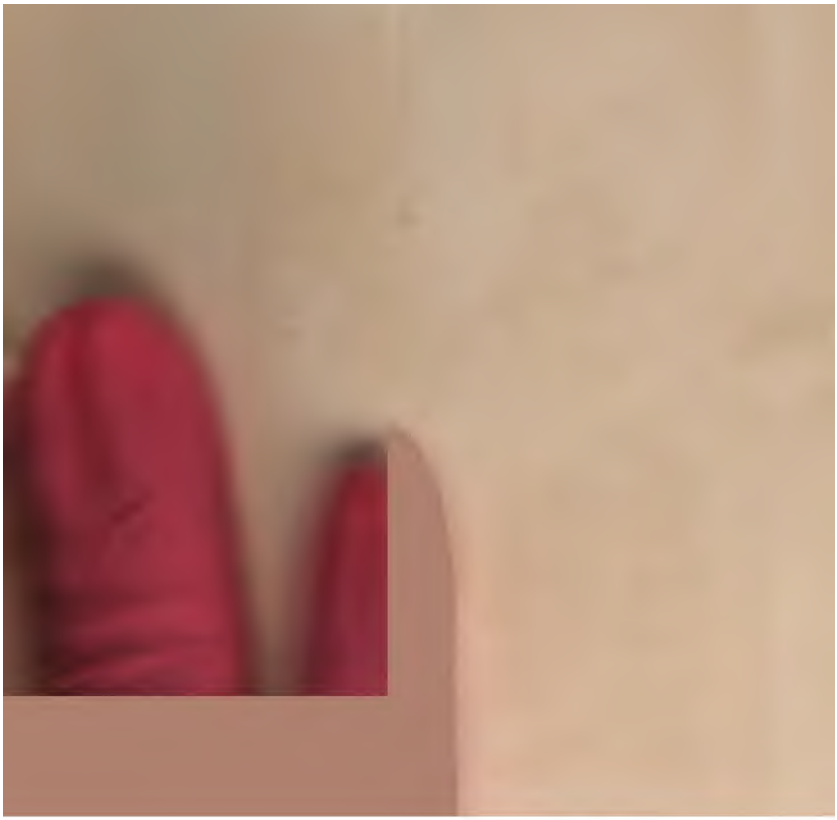

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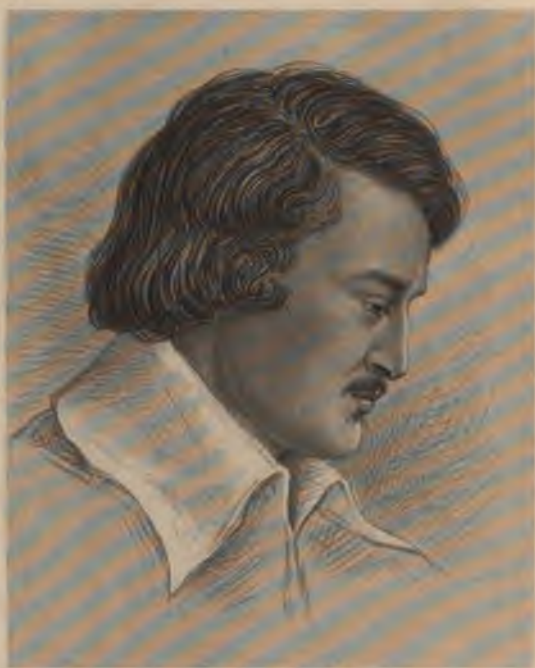

AGASSIZ AT THE AGE OF NINETEEN
From a Pastel Drawing

AGASSIZ

CORRESPONDENCE

AGASSIZ

NEW YORK

LOUIS AGASSIZ

HIS LIFE AND CORRESPONDENCE

EDITED BY

ELIZABETH CARY AGASSIZ

BOSTON AND NEW YORK
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PREFACE.

I AM aware that this book has neither the fullness of personal narrative, nor the closeness of scientific analysis, which its too comprehensive title might lead the reader to expect. A word of explanation is therefore needed. I thought little at first of the general public, when I began to weave together in narrative form the facts, letters, and journals contained in this volume. My chief object was to prevent the dispersion and final loss of scattered papers which had an unquestionable family value. But, as my work grew upon my hands, I began to feel that the story of an intellectual life, which was marked by such rare coherence and unity of aim, might have a wider interest and usefulness; might, perhaps,

serve as a stimulus and an encouragement to others. For this reason, and also because I am inclined to believe that the European portion of the life of Louis Agassiz is little known in his adopted country, while its American period must be unfamiliar to many in his native land, I have determined to publish the material here collected.

The book labors under the disadvantage of being in great part a translation. The correspondence for the first part was almost wholly in French and German, so that the choice lay between a patch-work of several languages or the unity of one, burdened as it must be with the change of version. I have accepted what seemed to me the least of these difficulties.

Besides the assistance of my immediate family, including the revision of the text by my son Alexander Agassiz, I have been indebted to my friends Dr. and Mrs. Hagen and to the late Professor Guyot for advice on special points.

As will be seen from the list of illustrations, I have also to thank Mrs. John W. Elliot for her valuable aid in that part of the work.

On the other side of the water I have had most faithful and efficient collaborators. Mr. Auguste Agassiz, who survived his brother Louis several years, and took the greatest interest in preserving whatever concerned his scientific career, confided to my hands many papers and documents belonging to his brother's earlier life. After his death, his cousin and brother-in-law, Mr. Auguste Mayor, of Neuchâtel, continued the same affectionate service. Without their aid I could not have completed the narrative as it now stands.

The friend last named also selected from the glacier of the Aar, at the request of Alexander Agassiz, the boulder which now marks his father's grave. With unwearied patience Mr. Mayor passed hours of toilsome search among the blocks of the moraine near the site of the old "Hôtel des Neuchâtelois," and

chose at last a stone so monumental in form that not a touch of the hammer was needed to fit it for its purpose. In conclusion I allow myself the pleasure of recording here my gratitude to him and to all who have aided me in my work.

ELIZABETH C. AGASSIZ.

CAMBRIDGE, MASS., *June* 11, 1885.

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LOUIS AGASSIZ.

PART I. IN EUROPE.

CHAPTER I.

1807–1827: TO ÆT. 20.

Birthplace. — Influence of his Mother. — Early Love of Natural History. — Boyish Occupations. — Domestic Education. — First School. — Vacations. — Commercial Life renounced. — College of Lausanne. — Choice of Profession. — Medical School of Zurich. — Life and Studies there. — University of Heidelberg. — Studies interrupted by Illness. — Return to Switzerland. — Occupations during Convalescence.

JEAN LOUIS RODOLPHE AGASSIZ was born May 28, 1807, at the village of Motier, on the Lake of Morat. His father, Louis Rodolphe Agassiz, was a clergyman; his mother, Rose Mayor, was the daughter of a physician whose home was at Cudrefin, on the shore of the Lake of Neuchâtel.

The parsonages in Switzerland are frequently pretty and picturesque. That of Motier, looking upon the lake and sheltered by a hill which commands a view over the whole

chain of the Bernese Alps, was especially so. It possessed a vineyard large enough to add something in good years to the small salary of the pastor; an orchard containing, among other trees, an apricot famed the country around for the unblemished beauty of its abundant fruit; a good vegetable garden, and a delicious spring of water flowing always fresh and pure into a great stone basin behind the house. That stone basin was Agassiz's first aquarium; there he had his first collection of fishes.[1]

It does not appear that he had any precocious predilection for study, and his parents, who for the first ten years of his life were his only teachers, were too wise to stimulate his mind beyond the ordinary attainments of his age. Having lost her first four children in infancy, his mother watched with trembling solicitude over his early years. It was perhaps for this reason that she was drawn so closely to her boy, and understood that his love of nature, and especially of all living

[1] After his death a touching tribute was paid to his memory by the inhabitants of his birthplace. With appropriate ceremonies, a marble slab was placed above the door of the parsonage of Motier, with this inscription, "J. Louis Agassiz, célèbre naturaliste, est né dans cette maison, le 28 Mai, 1807."

things, was an intellectual tendency, and not simply a child's disposition to find friends and playmates in the animals about him. In later years her sympathy gave her the key to the work of his manhood, as it had done to the sports of his childhood. She remained his most intimate friend to the last hour of her life, and he survived her but six years.

Louis's love of natural history showed itself almost from infancy. When a very little fellow he had, beside his collection of fishes, all sorts of pets: birds, field-mice, hares, rabbits, guinea-pigs, etc., whose families he reared with the greatest care. Guided by his knowledge of the haunts and habits of fishes, he and his brother Auguste became the most adroit of young fishermen, — using processes all their own and quite independent of hook, line, or net. Their hunting grounds were the holes and crevices beneath the stones or in the water-washed walls of the lake shore. No such shelter was safe from their curious fingers, and they acquired such dexterity that when bathing they could seize the fish even in the open water, attracting them by little arts to which the fish submitted as to a kind of fascination. Such amusements are no doubt the delight of many a lad living in the coun-

try, nor would they be worth recording except as illustrating the unity of Agassiz's intellectual development from beginning to end. His pet animals suggested questions, to answer which was the task of his life; and his intimate study of the fresh-water fishes of Europe, later the subject of one of his important works, began with his first collection from the Lake of Morat.

As a boy he amused himself also with all kinds of handicrafts on a small scale. The carpenter, the cobbler, the tailor, were then as much developed in him as the naturalist. In Swiss villages it was the habit in those days for the trades-people to go from house to house in their different vocations. The shoemaker came two or three times a year with all his materials, and made shoes for the whole family by the day; the tailor came to fit them for garments which he made in the house; the cooper arrived before the vintage, to repair old barrels and hogsheads or to make new ones, and to replace their worn-out hoops; in short, to fit up the cellar for the coming season. Agassiz seems to have profited by these lessons as much as by those he learned from his father; and when a very little fellow, he could cut and put together a well-fitting pair of shoes

for his sisters' dolls, was no bad tailor, and could make a miniature barrel that was perfectly water-tight. He remembered these trivial facts as a valuable part of his incidental education. He said he owed much of his dexterity in manipulation, to the training of eye and hand gained in these childish plays.

Though fond of quiet, in-door occupation, he was an active, daring boy. One winter day when about seven years of age, he was skating with his little brother Auguste, two years younger than himself, and a number of other boys, near the shore of the lake. They were talking of a great fair held that day at the town of Morat, on the opposite side of the lake, to which M. Agassiz had gone in the morning, not crossing upon the ice, however, but driving around the shore. The temptation was too strong for Louis, and he proposed to Auguste that they should skate across, join their father at the fair, and come home with him in the afternoon. They started accordingly. The other boys remained on their skating ground till twelve o'clock, the usual dinner hour, when they returned to the village. Mme. Agassiz was watching for her boys, thinking them rather late, and on in-

quiring for them among the troop of urchins coming down the village street she learned on what errand they had gone. Her anxiety may be imagined. The lake was not less than two miles across, and she was by no means sure that the ice was safe. She hurried to an upper window with a spy-glass to see if she could descry them anywhere. At the moment she caught sight of them, already far on their journey, Louis had laid himself down across a fissure in the ice, thus making a bridge for his little brother, who was creeping over his back. Their mother directed a workman, an excellent skater, to follow them as swiftly as possible. He overtook them just as they had gained the shore, but it did not occur to him that they could return otherwise than they had come, and he skated back with them across the lake. Weary, hungry, and disappointed, the boys reached the house without having seen the fair or enjoyed the drive home with their father in the afternoon.

When he was ten years old, Agassiz was sent to the college for boys at Bienne, thus exchanging the easy rule of domestic instruction for the more serious studies of a public school. He found himself on a level with his class, however, for his father was an admirable

teacher. Indeed it would seem that Agassiz's own passion for teaching, as well as his love of young people and his sympathy with intellectual aspiration everywhere, was an inheritance. Wherever his father was settled as pastor, at Motier, at Orbe, and later at Concise, his influence was felt in the schools as much as in the pulpit. A piece of silver remains, a much prized heir-loom in the family, given to him by the municipality of Orbe in acknowledgment of his services in the schools.

The rules of the school at Bienne were rather strict, but the life led by the boys was hardy and invigorating, and they played as heartily as they worked. Remembering his own school life, Agassiz often asked himself whether it was difference of climate or of method, which makes the public school life in the United States so much more trying to the health of children than the one under which he was brought up. The boys and girls in our public schools are said to be overworked with a session of five hours, and an additional hour or two of study at home. At the College of Bienne there were nine hours of study, and the boys were healthy and happy. Perhaps the secret might be found in the frequent interruption, two or three hours of

study alternating with an interval for play or rest. Agassiz always retained a pleasant impression of the school and its teachers. Mr. Rickly, the director, he regarded with an affectionate respect, which ripened into friendship in maturer years.

The vacations were, of course, hailed with delight, and as Motier was but twenty miles distant from Bienne, Agassiz and his younger brother Auguste, who joined him at school a year later, were in the habit of making the journey on foot. The lives of these brothers were so closely interwoven in their youth that for many years the story of one includes the story of the other. They had everything in common, and with their little savings they used to buy books, chosen by Louis, the foundation, as it proved, of his future library.

Long before dawn on the first day of vacation the two bright, active boys would be on their homeward way, as happy as holiday could make them, especially if they were returning for the summer harvest or the autumn vintage. The latter was then, as now, a season of festivity. In these more modern days something of its primitive picturesqueness may have been lost; but when Agassiz was a boy, all the ordinary occupations were

THE BIRTHPLACE OF LOUIS AGASSIZ.

given up for this important annual business, in which work and play were so happily combined. On the appointed day the working people might be seen trooping in from neighboring cantons, where there were no vineyards, to offer themselves for the vintage. They either camped out at night, sleeping in the open air, or found shelter in the stables and outhouses. During the grape gathering the floor of the barn and shed at the parsonage of Motier was often covered in the evening with tired laborers, both men and women. Of course, when the weather was fine, these were festival days for the children. A bushel basket, heaped high with white and amber bunches, stood in the hall, or in the living room of the family, and young and old were free to help themselves as they came and went. Then there were the frolics in the vineyard, the sweet cup of *must* (unfermented juice of the grape), and the ball on the last evening at the close of the merry-making.

Sometimes the boys passed their vacations at Cudrefin, with their grandfather Mayor. He was a kind old man, much respected in his profession, and greatly beloved for his benevolence. His little white horse was well known in all the paths and by-roads of the

country around, as he went from village to village among the sick. The grandmother was frail in health, but a great favorite among the children, for whom she had an endless fund of stories, songs, and hymns. Aunt Lisette, an unmarried daughter, who long lived to maintain the hospitality of the old Cudrefin house and to be beloved as the kindest of maiden aunts by two or three generations of nephews and nieces, was the domestic providence of these family gatherings, where the praises of her excellent dishes were annually sung. The roof was elastic; there was no question about numbers, for all came who could; the more, the merrier, with no diminution of good cheer.

The Sunday after Easter was the great popular fête. Then every house was busy coloring Easter eggs and making fritters. The young girls and the lads of the village, the former in their prettiest dresses and the latter with enormous bouquets of artificial flowers in their hats, went together to church in the morning. In the afternoon the traditional match between two runners, chosen from the village youths, took place. They were dressed in white, and adorned with bright ribbons. With music before them, and followed by all

the young people, they went in procession to the place where a quantity of Easter eggs had been distributed upon the ground. At a signal the runners separated, the one to pick up the eggs according to a prescribed course, the other to run to the next village and back again. The victory was to the one who accomplished his task first, and he was proclaimed king of the feast. Hand in hand the runners, followed as before by all their companions, returned to join in the dance now to take place before the house of Dr. Mayor. After a time the festivities were interrupted by a little address in *patois* from the first musician, who concluded by announcing from his platform a special dance in honor of the family of Dr. Mayor. In this dance the family with some of their friends and neighbors took part, — the young ladies dancing with the peasant lads and the young gentlemen with the girls of the village, — while the rest formed a circle to look on.

Thus, between study and recreation, the four years which Agassiz's father and mother intended he should pass at Bienne drew to a close. A yellow, time-worn sheet of foolscap, on which during the last year of his school-life he wrote his desiderata in the way of

books, tells something of his progress and his aspirations at fourteen years of age. "I wish," so it runs, "to advance in the sciences, and for that I need d'Anville, Ritter, an Italian dictionary, a Strabo in Greek, Mannert and Thiersch; and also the works of Malte-Brun and Seyfert. I have resolved, as far as I am allowed to do so, to become a man of letters, and at present I can go no further: 1st, in ancient geography, for I already know all my note-books, and I have only such books as Mr. Rickly can lend me; I must have d'Anville or Mannert; 2d, in modern geography, also, I have only such books as Mr. Rickly can lend me, and the Osterwald geography, which does not accord with the new divisions; I must have Ritter or Malte-Brun; 3d, for Greek I need a new grammar, and I shall choose Thiersch; 4th, I have no Italian dictionary, except one lent me by Mr. Moltz; I must have one; 5th, for Latin I need a larger grammar than the one I have, and I should like Seyfert; 6th, Mr. Rickly tells me that as I have a taste for geography he will give me a lesson in Greek (gratis), in which we would translate Strabo, provided I can find one. For all this I ought to have about twelve louis. I should like

to stay at Bienne till the month of July, and afterward serve my apprenticeship in commerce at Neuchâtel for a year and a half. Then I should like to pass four years at a university in Germany, and finally finish my studies at Paris, where I would stay about five years. Then, at the age of twenty-five, I could begin to write."

Agassiz's note-books, preserved by his parents, who followed the education of their children with the deepest interest, give evidence of his faithful work both at school and college. They form a great pile of manuscript, from the paper copy-books of the school-boy to the carefully collated reports of the college student, begun when the writer was ten or eleven years of age and continued with little interruption till he was eighteen or nineteen. The later volumes are of nearly quarto size and very thick, some of them containing from four to six hundred closely covered pages; the handwriting is small, no doubt for economy of space, but very clear. The subjects are physiological, pathological, and anatomical, with more or less of general natural history. This series of books is kept with remarkable neatness. Even in the boy's copy-books, containing exercises in Greek, Latin, French and

German, with compositions on a variety of topics, the writing is even and distinct, with scarcely a blot or an erasure. From the very beginning there is a careful division of subjects under clearly marked headings, showing even then a tendency toward an orderly classification of facts and thoughts.

It is evident from the boyish sketch which he drew of his future plans that the hope of escaping the commercial life projected for him, and of dedicating himself to letters and learning, was already dawning. He had begun to feel the charm of study, and his scientific tastes, though still pursued rather as the pastimes of a boy than as the investigations of a student, were nevertheless becoming more and more absorbing. He was fifteen years old and the time had come when, according to a purpose long decided upon, he was to leave school and enter the business house of his uncle, François Mayor, at Neuchâtel. He begged for a farther delay, to be spent in two additional years of study at the College of Lausanne. He was supported in his request by several of his teachers, and especially by Mr. Rickly, who urged his parents to encourage the remarkable intelligence and zeal already shown by their son in his

studies. They were not difficult to persuade; indeed, only want of means, never want of will, limited the educational advantages they gave to their children.

It was decided, therefore, that he should go to Lausanne. Here his love for everything bearing on the study of nature was confirmed. Professor Chavannes, Director of the Cantonal Museum, in whom he found not only an interesting teacher, but a friend who sympathized with his favorite tastes, possessed the only collection of Natural History in the Canton de Vaud. To this Agassiz now had access. His uncle, Dr. Mathias Mayor, his mother's brother and a physician of note in Lausanne, whose opinion had great weight with M. and Mme. Agassiz, was also attracted by the boy's intelligent interest in anatomy and kindred subjects. He advised that his nephew should be allowed to study medicine, and at the close of Agassiz's college course at Lausanne the commercial plan was finally abandoned, and he was permitted to choose the medical profession as the one most akin to his inclination.

Being now seventeen years of age, he went to the medical school of Zurich. Here, for the first time, he came into contact with men

whose instruction derived freshness and vigor from their original researches. He was especially indebted to Professor Schinz, a man of learning and ability, who held the chair of Natural History and Physiology, and who showed the warmest interest in his pupil's progress. He gave Agassiz a key to his private library, as well as to his collection of birds. This liberality was invaluable to one whose poverty made books an unattainable luxury. Many an hour did the young student pass at that time in copying books which were beyond his means, though some of them did not cost more than a dollar a volume. His brother Auguste, still his constant companion, shared this task, a pure labor of love with him, for the books were more necessary to Louis's studies than to his own.

During the two years passed by Agassiz in Zurich he saw little of society beyond the walls of the university. His brother and he had a pleasant home in a private house, where they shared the family life of their host and hostess. In company with them, Agassiz made his first excursion of any importance into the Alps. They ascended the Righi and passed the night there. At about sunset a fearful thunder-storm gathered below them,

while on the summit of the mountain the weather remained perfectly clear and calm. Under a blue sky they watched the lightning, and listened to the thunder in the dark clouds, which were pouring torrents of rain upon the plain and the Lake of Lucerne. The storm lasted long after night had closed in, and Agassiz lingered when all his companions had retired to rest, till at last the clouds drifted softly away, letting down the light of moon and stars on the lake and landscape. He used to say that in his subsequent Alpine excursions he had rarely witnessed a scene of greater beauty.

Such of his letters from Zurich as have been preserved have only a home interest. In one of them, however, he alludes to a curious circumstance, which might have changed the tenor of his life. He and his brother were returning on foot, for the vacation, from Zurich to their home which was now in Orbe, where their father and mother had been settled since 1821. Between Neuchâtel and Orbe they were overtaken by a traveling carriage. A gentleman who was its sole occupant invited them to get in, made them welcome to his lunch, talked to them of their student life, and their future plans, and drove

them to the parsonage, where he introduced himself to their parents. Some days afterward M. Agassiz received a letter from this chance acquaintance, who proved to be a man in affluent circumstances, of good social position, living at the time in Geneva. He wrote to M. Agassiz that he had been singularly attracted by his elder son, Louis, and that he wished to adopt him, assuming henceforth all the responsibility of his education and his establishment in life. This proposition fell like a bomb-shell into the quiet parsonage. M. Agassiz was poor, and every advantage for his children was gained with painful self-sacrifice on the part of both parents. How then refuse such an opportunity for one among them, and that one so gifted? After anxious reflection, however, the father, with the full concurrence of his son, decided to decline an offer which, brilliant as it seemed, involved a separation and might lead to a false position. A correspondence was kept up for years between Louis and the friend he had so suddenly won, and who continued to interest himself in his career. Although it had no sequel, this incident is mentioned as showing a kind of personal magnetism which, even as child and boy, Agassiz unconsciously exercised over others.

From Zurich, Agassiz went to the University of Heidelberg, where we find him in the spring of 1826.

TO HIS FATHER.

HEIDELBERG, *April* 24, 1826.

. . . Having arrived early enough to see something of the environs before the opening of the term, I decided to devote each day to a ramble in one direction or another, in order to become familiar with my surroundings. I am the more glad to have done this as I have learned that after the lectures begin there will be no further chance for such interruptions, and we shall be obliged to stick closely to our work at home.

Our first excursion was to Neckarsteinach, two and a half leagues from here. The road follows the Neckar, and at certain places rises boldly above the river, which flows between two hills, broken by rocks of the color of red chalk, which often jut out from either side. Farther on the valley widens, and a pretty rising ground, crowned by ruins, suddenly presents itself in the midst of a wide plain, where sheep are feeding. Neckarsteinach itself is only a little village, containing, however, three castles, two of which are in ruins.

The third is still inhabited, and commands a magnificent view. In the evening we returned to Heidelberg by moonlight.

Another day we started for what is here called "The Mountain," though it is at most no higher than Le Suchet. As the needful supplies are not to be obtained there, we took our provisions with us. We had so much fun out of this, that I must tell you all about it. In the morning Z—— bought at the market veal, liver, and bacon enough to serve for three persons during two days. To these supplies we added salt, pepper, butter, onions, bread, and some jugs of beer. One of us took two saucepans for cooking, and some alcohol. Arrived at the summit of our mountain, we looked out for a convenient spot, and there we cooked our dinner. It did not take long, nor can I say whether all was done according to the rules of art. But this I know, — that never did a meal seem to me better. We wandered over the mountain for the rest of the day, and at evening came to a house where we prepared our supper after the same fashion, to the great astonishment of the assembled household, and especially of an old woman who regretted the death of her husband, because she said it would certainly

have amused him. We slept on the ground on some straw, and returned to Heidelberg the next day in time for dinner. The following day we went to Mannheim to visit the theatre. It is very handsome and well appointed, and we were fortunate in happening upon an excellent opera. Beyond this, I saw nothing of Mannheim except the house of Kotzebue and the place where Sand was beheaded.

To-day I have made my visits to the professors. For three among them I had letters from Professors Schinz and Hirzel. I was received by all in the kindest way. Professor Tiedemann, the Chancellor, is a man about the age of papa and young for his years. He is so well-known that I need not undertake his panegyric here. As soon as I told him that I brought a letter from Zurich, he showed me the greatest politeness, offered me books from his library; in one word, said he would be for me here what Professor Schinz, with whom he had formerly studied, had been for me in Zurich. After the opening of the term, when I know these gentlemen better, I will tell you more about them. I have still to describe my home, chamber, garden, people of the house, etc.

The next letter fills in this frame-work.

TO HIS FATHER.

HEIDELBERG, *May* 24, 1826.

. . . According to your request, I am going to write you all possible details about my host, the employment of my time, etc., etc. Mr. ——, my "philister," is a tobacco merchant in easy circumstances, having a pretty house in the faubourg of the city. My windows overlook the town, and my prospect is bounded by a hill situated to the north of Heidelberg. At the back of the house is a large and fine garden, at the foot of which is a very pretty summer-house. There are also several clumps of trees in the garden, and an aviary filled with native birds. . . .

Since each day in term time is only the repetition of every other, the account of one will give an idea of all, especially as I follow with regularity the plan of study I have formed. Every morning I rise at six o'clock, dress, and breakfast. At seven I go to my lectures, given during the morning in the Museum building, next to which is the anatomical laboratory. If, in the interval, I have a free hour, as sometimes happens from ten to eleven, I occupy it in making anatom-

ical preparations. I shall tell you more of that and of the Museum another time. From twelve to one I practice fencing. We dine at about one o'clock, after which I walk till two, when I return to the house and to my studies till five o'clock. From five to six we have a lecture from the renowned Tiedemann. After that, I either take a bath in the Neckar or another walk. From eight to nine I resume my special work, and then, according to my inclination, go to the Swiss club, or, if I am tired, to bed. I have my evening service and talk silently with you, believing that at that hour you also do not forget your Louis, who thinks always of you. . . . As soon as I know, for I cannot yet make an exact estimate, I will write you as nearly as possible what my expenses are likely to be. Sometimes there may be unlooked-for expenditures, as, for instance, six crowns for a matriculation paper. But be assured that at all events I shall restrict myself to what is absolutely necessary, and do my best to economize. The same of the probable duration of my stay in Heidelberg; I shall certainly not prolong it needlessly. . . .

Now for the first time the paths of the

two brothers separated, Auguste returning from Zurich to Neuchâtel, where he entered into business. It chanced, however, that in one of the first acquaintances made by Louis in Heidelberg he found not only a congenial comrade, but a friend for life, and in after years a brother. Professor Tiedemann, by whom Agassiz had been so kindly received, recommended him to seek the acquaintance of young Alexander Braun, an ardent student, and an especial lover of botany. At Tiedemann's lecture the next day Agassiz's attention was attracted by a young man who sat next him, and who was taking very careful notes and illustrating them. There was something very winning in his calm, gentle face, full of benevolence and intelligence. Convinced by his manner of listening to the lecture and transcribing it that this was the student of whom Tiedemann had spoken, Agassiz turned to his neighbor as they both rose at the close of the hour, and said, "Are you Alex. Braun?" "Yes, and you, Louis Agassiz?" It seems that Professor Tiedemann, who must have had a quick eye for affinities in the moral as well as in the physical world, had said to Braun also, that he advised him to make the acquaintance of a young Swiss natu-

ralist who had just come, and who seemed full of enthusiasm for his work. The two young men left the lecture-room together, and from that time their studies, their excursions, their amusements, were undertaken and pursued in each other's company. In their long rambles, while they collected specimens in their different departments of Natural History, Braun learned zoölogy from Agassiz, and he, in his turn, learned botany from Braun. This was, perhaps, the reason why Alexander Braun, afterward Director of the Botanical Gardens in Berlin, knew more of zoölogy than other botanists, while Agassiz himself combined an extensive knowledge of botany with his study of the animal kingdom. That the attraction was mutual may be seen by the following extract from a letter of Alexander Braun to his father.

BRAUN TO HIS FATHER.

HEIDELBERG, *May* 12, 1826.

. . . In my leisure hours, between the forenoon and afternoon lectures, I go to the dissecting-room, where, in company with another young naturalist who has appeared like a rare comet on the Heidelberg horizon, I dissect all manner of beasts, such as dogs, cats, birds, fishes, and even smaller fry, snails, but-

terflies, caterpillars, worms, and the like. Beside this, we always have from Tiedemann the very best books for reference and comparison, for he has a fine library, especially rich in anatomical works, and is particularly friendly and obliging to us.

In the afternoon from two to three I attend Geiger's lectures on pharmaceutical chemistry, and from five to six those of Tiedemann on comparative anatomy. In the interval, I sometimes go with this naturalist, so recently arrived among us (his name is Agassiz, and he is from Orbe), on a hunt after animals and plants. Not only do we collect and learn to observe all manner of things, but we have also an opportunity of exchanging our views on scientific matters in general. I learn a great deal from him, for he is much more at home in zoölogy than I am. He is familiar with almost all the known mammalia, recognizes the birds from far off by their song, and can give a name to every fish in the water. In the morning we often stroll together through the fish market, where he explains to me all the different species. He is going to teach me how to stuff fishes, and then we intend to make a collection of all the native kinds. Many other useful things he knows;

speaks German and French equally well, English and Italian fairly, so that I have already appointed him to be my interpreter on some future vacation trip to Italy. He is well acquainted with ancient languages also, and studies medicine besides. . . .

A few lines from Braun to his mother, several weeks later, show that this first enthusiasm, poured out with half-laughing extravagance to his father, was ripening into friendship of a more serious character.

BRAUN TO HIS MOTHER.

HEIDELBERG, *June* 1, 1826.

. . . I am very happy now that I have found some one whose occupations are the same as mine. Before Agassiz came I was obliged to make my excursions almost always alone, and to study in hermit-like isolation. After all, two people working together can accomplish far more than either one can do alone. In order, for instance, to utilize the interval spent in the time-consuming and mechanical work of preparing specimens, pinning insects and the like, we have agreed that while one is so employed the other shall read aloud. In this way we shall go through

various works on physiology, anatomy, and zoölogy. . . .

Next to Alexander Braun, Agassiz's most congenial companion at Heidelberg was Karl Schimper, a friend of Braun, and like him a young botanist of brilliant promise. The three soon became inseparable. Agassiz had many friends and companions at the university beside those who, on account of their influence upon his after life, are mentioned here. He was too affectionate not to be a genial companion among his young countrymen of whom there were many at Heidelberg, where they had a club and a gymnasium of their own. In the latter, Agassiz bore his part in all the athletic sports, being distinguished both as a powerful gymnast and an expert fencer.

Of the professors then at Heidelberg, Leuckart, the zoölogist, was, perhaps, the most inspiriting. His lectures were full of original suggestions and clever hypotheses, which excited and sometimes amused his listeners. He knew how to take advantage of the enthusiasm of his brighter pupils, and, at their request, gave them a separate course of instruction on special groups of animals; not

without some personal sacrifice, for these extra lectures were given at seven o'clock in the morning, and the students were often obliged to pull their professor out of bed for the purpose. The fact that they did so shows at least the friendly relation existing between teacher and scholars. With Bischoff the botanist also, the young friends were admitted to the most kindly intercourse. Many a pleasant botanical excursion they had with him, and they owed to him a thorough and skillful instruction in the use of the microscope, handled by him like a master. Tiedemann's lectures were very learned, and Agassiz always spoke of his old teacher in comparative anatomy and physiology with affectionate respect and admiration. He was not, however, an inspiring teacher, and though an excellent friend to the students, they had no such intimate personal relations with him as with Leuckart and Bischoff. From Bronn, the paleontologist, they received an immense amount of special information, but his instruction was minute in details rather than suggestive in ideas; and they were glad when their professor, finding that the course must be shortened for want of time, displayed to them his magnificent collection of fossils, and with the help

of the specimens, developed his subject in a more general and practical way.[1] Of the medical professors, Nägeli was the more interesting, though the reputation of Chelius brought him a larger audience. If there was however any lack of stimulus in the lecture-rooms, the young friends made good the deficiency by their own indefatigable and intelligent study of nature, seeking to satisfy their craving for knowledge by every means within their reach.[2]

As the distance and expense made it impossible for Agassiz to spend his vacations with his family in Switzerland, it soon became the habit for him to pass the holidays with his new friend at Carlsruhe. For a young man of his tastes and acquirements a more charming home-life than the one to which he was here introduced can hardly be imagined. The

[1] This collection was purchased in 1859 by the Museum of Comparative Zoölogy in Cambridge, Massachusetts, and Agassiz had thus the pleasure of teaching his American pupils from the very collection in which he had himself made his first important paleontological studies.

[2] The material for this account of the student life of the two friends at Heidelberg and of their teachers was chiefly furnished by Alexander Braun himself at the close of his own life, after the death of Agassiz. The later sketches of the Professors at Munich in 1832 were drawn in great part from the same source.

whole atmosphere was in harmony with the pursuits of the students. The house was simple in its appointments, but rich in books, music, and in all things stimulating to the thought and imagination. It stood near one of the city gates which opened into an extensive oak forest, in itself an admirable collecting ground for the naturalist. At the back certain rooms, sheltered by the spacious garden from the noise of the street, were devoted to science. In the first of these rooms the father's rich collection of minerals was arranged, and beyond this were the laboratories of his sons and their friends, where specimens of all sorts, dried and living plants, microscopes and books of reference, covered the working tables. Here they brought their treasures; here they drew, studied, dissected, arranged their specimens; here they discussed the theories, with which their young brains were teeming, about the growth, structure, and relations of animals and plants.[1]

From this house, which became a second home to Agassiz, he wrote to his father in the Christmas holidays of 1826: . . . "My happiness would be perfect were it not for

[1] See *Biographical Memoir of Louis Agassiz*, by Arnold Guyot, in the *Proceedings of U. S. National Academy.*

the painful thought which pursues me everywhere, that I live on your privations; yet it is impossible for me to diminish my expenses farther. You would lift a great weight from my heart if you could relieve yourself of this burden by an arrangement with my uncle at Neuchâtel. I am confident that when I have finished my studies I could easily make enough to repay him. At all events, I know that you cannot pay the whole at once, and therefore in telling me frankly what are our resources for this object you would do me the greatest favor. Until I know that, I cannot be at peace. Otherwise, I am well, going on as usual, always working as hard as I can, and I believe all the professors whose lectures I attend are satisfied with me." . . . His father was also pleased with his conduct and with his progress, for about this time he writes to a friend, "We have the best possible news of Louis. Courageous, industrious, and discreet, he pursues honorably and vigorously his aim, namely, the degree of Doctor of Medicine and Surgery."

In the spring of 1827 Agassiz fell ill of a typhus fever prevalent at the university as an epidemic. His life was in danger for many days. As soon as he could be moved, Braun

took him to Carlsruhe, where his convalescence was carefully watched over by his friend's mother. Being still delicate he was advised to recruit in his native air, and he returned to Orbe, accompanied by Braun, who did not leave him till he had placed him in safety with his parents. The following extracts from the correspondence between himself and Braun give some account of this interval spent at home.

AGASSIZ TO BRAUN.

ORBE, *May* 26, 1827.

. . . Since I have been here, I have walked faithfully and have collected a good number of plants which are not yet dry. I have more than one hundred kinds, about twenty specimens of each. As soon as they can be taken out of the press, I 'll send you a few specimens of each kind with a number attached so that you may identify them. Take care that you do not displace the numbers in opening the package. Should you want more of any particular kind let me know; also whether Schimper wishes for any. . . . At Neuchâtel I had the good fortune to find at least thirty specimens of Bombinator obstetricans with the eggs. Tell Dr. Leuckart that

I will bring him some, — and some for you also. I kept several alive laid in damp moss; after fourteen days the eggs were almost as large as peas, and the little tadpoles moved about inside in all directions. The mother stripped the eggs from her legs, and one of the little tadpoles came out, but died for want of water. Then I placed the whole mass of eggs in a vessel filled with water, and behold! in about an hour some twenty young ones were swimming freely about. I shall spare no pains to raise them, and I hope, if I begin aright, to make fine toads of them in the end. My oldest sister is busy every day in making drawings for me to illustrate their gradual development. . . . I dissect now as much and on as great a variety of subjects as possible. This makes my principal occupation. I am often busy too with Oken. His "Natur-philosophie" gives me the greatest pleasure. I long for my box, being in need of my books, which, no doubt, you have sent. Meantime, I am reading something of Universal History, and am not idle, as you see. But I miss the evenings with you and Schimper at Heidelberg, and wish I were with you once more. I am afraid when that happy time does come, it will be only too short. . . .

BRAUN TO AGASSIZ.

HEIDELBERG, *May*, 1827.

. . . On Thursday evening, the 10th, I reached Heidelberg. The medical lectures did not begin till the second week of May, so that I have missed little, and almost regret having returned so soon. . . . I passed the last afternoon in Basel very pleasantly with Herr Roepper, to whom I must soon write. He gave me a variety of specimens, showed me many beautiful things, and told me much that was instructive. He is a genuine and excellent botanist, and no mere collector like the majority. Neither is he purely an observer like Dr. Bischoff, but a man who thinks. . . . Dr. Leuckart is in raptures about the eggs of the "Hebammen Kröte," and will raise them. . . . Schweiz takes your place in our erudite evening meetings. I have been lecturing lately on the metamorphosis of plants, and Schimper has propounded an entirely new and very interesting theory, which will, no doubt, find favor with you hereafter, about the significance of the circular and longitudinal fibres in organisms. Schimper is fruitful as ever in poetical and philosophical ideas, and has just now ventured upon a natural history of the mind. We

have introduced mathematics also, and he has advanced a new hypothesis about comets and their long tails. . . . Our chief botanical occupation this summer is the careful observation of all our plants, even the commonest, and the explanation of whatever is unusual or enigmatical in their structure. We have already cracked several such nuts, but many remain to be opened. All such puzzling specimens are spread on single sheets and set aside. . . . But more of this when we are together again. . . . Dr. Leuckart begs you to study carefully the "Hebammen Unke;"[1] to notice whether the eggs are already fecundated when they are in the earth, or whether they copulate later in the water, or whether the young are hatched on land, and what is their tadpole condition, etc. All this is still unknown. . . .

AGASSIZ TO BRAUN.

ORBE, *June* 10, 1827.

. . . Last week I made a very pleasant excursion. You will remember that I have often spoken to you of Pastor Mellet at Vallorbe, who is much interested in the study of the six-legged insects. He invited me to go

[1] Bombinator obstetricans referred to in a former letter.

to Vallorbe with him for some days, and I passed a week there, spending my time most agreeably. We went daily on a search after insects; the booty was especially rich in beetles and butterflies. . . . I examined also M. Mellet's own most excellent collection of beetles and butterflies very carefully. He has many beautiful things, but almost exclusively Swiss or French, with a few from Brazil, — in all about 3,000 species. He gave me several, and promises more in the autumn. . . . He knows his beetles thoroughly, and observes their habits, haunts, and changes (as far as he can) admirably well. It is a pity though that while his knowledge of species is so accurate, he knows nothing of distribution, classification, or general relations. I tried to convince him that he ought to collect snails, slugs, and other objects of natural history, in the hope that he might gain thereby a wider insight. But he would not listen to it; he said he had enough to do with his *Vermine*.

My brother writes me that my box has arrived in Neuchâtel. As I am going there soon I will take it then. I rejoice in the thought of being in Neuchâtel, partly on account of my brother, Arnold (Guyot), and other friends, and partly that I may study the

fishes of our Swiss lakes. The species Cyprinus and Corregonus with their allies, including Salmo, are, as you know, especially difficult. I will preserve some small specimens in alcohol, and, if possible, dissect one of each, in order to satisfy myself as to their identity or specific variety. As the same kinds have received different names in different lakes, and since even differences of age have led to distinct designations, I will note all this down carefully. When I have made it clear to myself, I will send you a catalogue of the kinds we possess, specifying at the same time the lakes in which they occur. As I am on the chapter of fishes, I will ask you: 1. What are the gill arches? 2. What the gill blades? 3. What is the bladder in fishes? 4. What is the cloaca in the egg-laying animals? 5. What signify the many fins of fishes? 6. What is the sac which surrounds the eggs in Bombinator obstetricans? . . . Tell Dr. Leuckart I have already put aside for him the Corregonus umbla (if such it be), but can get no Silurus glanis.

I suppose you continue to come together now and then in the evening. . . . Make me a sharer in your new discoveries. Have you finished your essay on the physiology of plants, and what do you make of it? . . .

BRAUN TO AGASSIZ.

CARLSRUHE, *Whitsuntide, Monday*, 1827.

. . . I am in Carlsruhe, and as the package has not gone yet, I add a note. I have been analyzing and comparing all sorts of plants in our garden to-day, and I wish you had been with me. On my last sheet I send some nuts for you to pick, some wholly, some half, others not at all, cracked. Schimper is lost in the great impenetrable world of suns, with their planets, moons, and comets; he soars even into the region of the double stars, the milky way, and the nebulæ.

On a loose sheet come the "nuts to pick." It contains a long list of mooted questions, a few of which are given here to show the exchange of thought between Agassiz and his friend, the one propounding zoölogical, the other botanical, puzzles. Although most of the problems were solved long ago, it is not uninteresting to follow these young minds in their search after the laws of structure and growth, dimly perceived at first, but becoming gradually clearer as they go on. The very first questions hint at the law of Phyllotaxis, then wholly unknown, though now it makes

a part of the most elementary instruction in botany.[1]

"1. Where is the first diverging point of the stems and roots in plants, that is to say, the first geniculum?

"2. How do you explain the origin of those leaves on the stem which, not arising from distinct geniculi, are placed spirally or scattered around the stem?

"3. Why do some plants, especially trees (contrary to the ordinary course of development in plants), blossom before they have put forth leaves? (Elm-trees, willow-trees, and fruit-trees.)

"4. In what succession does the development of the organs of the flower take place? — and their formation in the bud? (Compare Campanula, Papaver.)

"5. What are the leaves of the Spergula?

"6. What are the tufted leaves of various pine-trees? (Pinus sylvestris, Strobus, Larix, etc.) . . .

"18. What is individuality in plants?"

The next letter contains Agassiz's answer to

[1] Botany owes to Alexander Braun and Karl Schimper the discovery of this law, by which leaves, however crowded, are so arranged around the stem as to divide the space with mathematical precision, thus giving to each leaf its fair share of room for growth.

Dr. Leuckart's questions concerning the eggs he had sent him, and some farther account of his own observations upon them.

AGASSIZ TO BRAUN.

NEUCHÂTEL, *June* 20, 1827.

. . . Now you shall hear what I know of the "Hebammen Kröte." How the fecundation takes place I know not, but it must needs be the same as in other kinds of the related Bombinator; *igneus* throws out almost as many eggs hanging together in clusters as *obstetricans; fuscus* throws them out from itself in strings (see Röseld's illustration). . . . I have now carefully examined the egg clusters of *obstetricans;* all the eggs are in one string and hang together. This string is a bag, in which the eggs lie inclosed at different distances, though they seem in the empty space to be fallen, thread-like, together. But if you stretch the thread and press the eggs, they change their places, and you can distinctly see that they lie free in the bag, having their own membranous envelopes corresponding to those of other batrachian eggs. Surely this species seeks the water at the time of fecundation, for so do all batrachians, the water being indeed a more fitting medium for fecundation

than the air. . . . It is certain that the eggs were already fecundated when we found them in the ground, for later, I found several not so far advanced as those you have, and yet after three weeks I had tadpoles from them. In those eggs which were in the lowest stage of development (how they may be earlier, *nescio*), nothing was clearly visible; they were simply little yellow balls. After some days, two small dark spots were to be seen marking the position of the eyes, and a longitudinal streak indicated the dorsal ridge. Presently everything became more distinct; the mouth and the nasal opening, the eyes and the tail, which lay in a half circle around the body; the skin was so transparent that the beating of the heart and the blood in the vessels could be easily distinguished; the yolk and the yolk sac were meanwhile sensibly diminished. The movements of the little animal were now quite perceptible, — they were quick and by starts. After three or four weeks the eggs were as large as peas; the bags had burst at the spots where the eggs were attached, and the little creatures filled the egg envelopes completely. They moved incessantly and very quickly. Now the female stripped off the eggs from her legs; she

seemed very uneasy, and sprang about constantly in the tank, but grew more quiet when I threw in more water. The eggs were soon free, and I laid them in a shallow vessel filled with fresh water. The restlessness among them now became greater, and behold! like lightning, a little tadpole slipped out of its egg, paused astonished, gazed on the greatness of the world, made some philanthropic observations, and swam quickly away. I gave them fresh water often, and tender green plants as well as bread to eat. They ate eagerly. Up to this time their different stages of development had been carefully drawn by my sister. I now went to Vallorbe; they promised at home to take care of my young brood, but when I returned the tadpoles had been forgotten, and I found them all dead; not yet decayed, however, and I could therefore preserve them in alcohol. The gills I have never seen, but I will watch to see whether they are turned inward. . . .

BRAUN TO AGASSIZ.

CARLSRUHE, *August* 9, 1827.

. . . This is to tell you that I have determined to leave Heidelberg in the autumn and set forth on a pilgrimage to Munich, and that

I invite you to be my traveling companion. Judging by a circumstantial letter from Döllinger, the instruction in the natural sciences leaves nothing to be desired. there. Add to this that the lectures are free, and the theatre open to students at twenty-four kreutzers. No lack of advantages and attractions, lodgings hardly more expensive than at Heidelberg, board equally cheap, beer plenty and good. Let all this persuade you. We shall hear Gruithuisen in popular astronomy, Schubert in general natural history, Martius in botany, Fuchs in mineralogy, Seiber in mathematics, Starke in physics, Oken in everything (he lectures in winter on the philosophy of nature, natural history, and physiology). The clinical instruction will be good. We shall soon be friends with all the professors. The library contains whatever is best in botany and zoölogy, and the collections open to the public are very rich. It is not known whether Schelling will lecture, but at all events certain of the courses will be of great advantage. Then little vacation trips to the Salzburg and Carinthian Alps are easily made from there! Write soon whether you will go and drink Bavarian beer and Schnapski with me, and write also when we are to see you in Heidelberg and

Carlsruhe. Remind me then to tell you about the theory of the root and poles in plants. As soon as I have your answer we will bespeak our lodgings from Döllinger, who will attend to that for us. Shall we again house together in one room, or shall we have separate cells in one comb, namely, under the same roof? The latter has its advantages for grass-gatherers and stone-cutters like ourselves. . . . Hammer away industriously at all sorts of rocks. I have collected at Auerbach, Weinheim, Wiesloch, etc. But before all else, observe carefully and often the wonderful structure of plants, those lovely children of the earth and sky. Ponder them with child-like mind, for children marvel at the phenomena of nature, while grown people often think themselves too wise to wonder, and yet they know little more than the children. But the thoughtful student recognizes the truth of the child's feeling, and with his knowledge of nature his wonder does but grow more and more. . . .

CHAPTER II.

1827–1828: ÆT. 20–21.

Arrival in Munich. — Lectures. — Relations with the Professors. — Schelling, Martius, Oken, Döllinger. — Relations with Fellow-Students. — The Little Academy. — Plans for Traveling. — Advice from his Parents. — Vacation Journey. — Tri-Centennial Dürer Festival at Nuremberg.

AGASSIZ accepted with delight his friend's proposition, and toward the end of October, 1827, he and Braun left Carlsruhe together for the University of Munich. His first letter to his brother is given in full, for though it contains crudities at which the writer himself would have smiled in after life, it is interesting as showing what was the knowledge possessed in those days by a clever, well-informed student of natural history.

TO HIS BROTHER AUGUSTE.

MUNICH, *November* 5, 1827.

. . . At last I am in Munich. I have so much to tell you that I hardly know where to begin. To be sure that I forget nothing,

however, I will give things in their regular sequence. First, then, the story of my journey; after that, I will tell you what I am doing here. As papa has, of course, shown you my last letter, I will continue where I left off. . . .

From Carlsruhe we traveled post to Stuttgart, where we passed the greater part of the day in the Museum, in which I saw many things quite new to me; a llama, for instance, almost as large as an ass. You know that this animal, which is of the genus Camelus, lives in South America, where it is to the natives what the camel is to the Arab; that is to say, it provides them with milk, wool, and meat, and is used by them, moreover, for driving and riding. There was a North American buffalo of immense size; also an elephant from Africa, and one from Asia; beside these, a prodigious number of gazelles, deer, cats, and dogs; skeletons of a hippopotamus and an elephant; and lastly the fossil bones of a mammoth. You know that the mammoth is no longer found living, and that the remains hitherto discovered lead to the belief that it was a species of carnivorous elephant. It is a singular fact that some fishermen, digging recently on the borders of the Obi, in Siberia, found one of these animals

frozen in a mass of ice, at a depth of sixty feet, so well preserved that it was still covered with hair, as in life. They melted the ice to remove the animal, but the skeleton alone remained complete; the hide was spoiled by contact with the air, and only a few pieces have been kept, one of which is in the Museum at Stuttgart. The hairs upon it are as coarse as fine twine, and nearly a foot long. The entire skeleton is at St. Petersburg in the Museum, and is larger than the largest elephant. One may judge by that what havoc such an animal must have made, if it was, as its teeth show it to have been, carnivorous. But what I would like to know is how this animal could wander so far north, and then in what manner it died, to be frozen thus, and remain intact, without decomposing, perhaps for countless ages. For it must have belonged to a former creation, since it is nowhere to be found living, and we have no instance of the disappearance of any kind of animal within the historic period. There were, besides, many other kinds of fossil animals. The collection of birds is very beautiful, but it is a pity that many of them are wrongly named. I corrected a number myself. . . . From Stuttgart we went to Esslingen, where we

were to visit two famous botanists. One was Herr Steudel; a sombre face, with long overhanging black hair, almost hiding the eyes, — a very Jewish face. He knows every book on botany that appears, has read them all, but cares little to see the plants themselves; in short, he is a true closet student. He has a large herbarium, composed in great part of plants purchased or received as gifts. The other, Professor Hochstetter, is an odd little man, stepping briskly about in his high boots, and having always a half suppressed smile on his lips whenever he takes the pipe from between his teeth. A very good man, however, and extremely obliging; he offered us every civility. As we desired not only to make their acquaintance, but to win from these botanists at least a few grasses, we presented ourselves like true *commis voyageurs*, with dried herbs to sell, each of us having a package of plants under his arm, — mine being Swiss, gathered last summer, Braun's from the Palatinate. We gave specimens to each, and received in exchange from Steudel some American plants; from Hochstetter some from Bohemia, and others from Moravia, his native country. From Esslingen we were driven to Goeppingen, in the most frightful weather

possible; it rained, snowed, froze, blew, all at once. It was a pity, since our road lay through one of the prettiest valleys I have ever seen, watered by the Neckar, and bordered on both sides by mountains of singular form and of considerable height. They are what the Würtembergers call the Suabian Alps, but I think that Chaumont is higher than the loftiest peak of their Alps. Here we found an old Heidelberg acquaintance, whose father owns a superb collection of fossils, especially of shells and zoöphytes. He has also quite a large collection of shells from the Adriatic Sea, but among these last not one was named. As we knew them, we made it our duty to arrange them, and in three hours his whole collection was labeled. Since he has duplicates of almost everything, he promised, as soon as he should have time, to make a selection from these and send them to us. Could we have stayed longer we might have picked out what we pleased, for he placed his collection at our disposal. But we were in haste to arrive here, so we begged him to send us, at his leisure, whatever he could give us.

Thence we continued our journey by post, because it still rained, and the roads were so detestable that with the best will in the world

we could not have made our way on foot. In the evening we reached Ulm, where, owing to the late hour, we saw almost nothing except the famous belfry of the cathedral, which was distinctly visible as we entered the city. After supper we continued our journey, still by post, wishing to be in Munich the next day. I have never seen anything more beautiful than the view as we left Ulm. The moon had risen and shone upon the belfry like broad daylight. On all sides extended a wide plain, unbroken by a single inequality, so far as the eye could distinguish, and cut by the Danube, glittering in the moonbeams. We crossed the plain during the night, and reached Augsburg at dawn. It is a beautiful city, but we merely stopped there for breakfast, and saw the streets only as we passed through them. On leaving Augsburg, the Tyrolean Alps, though nearly forty leagues away, were in sight. About eighteen leagues off was also discernible an immense forest; of this we had a nearer view as we advanced, for it encircles Munich at some distance from the town. We arrived here on Sunday, the 4th, in the afternoon. . . . My address is opposite the Sendlinger Thor No. 37. I have a very pretty chamber on the lower floor with an al-

cove for my bed. The house is situated outside the town, on a promenade, which makes it very pleasant. Moreover, by walking less than a hundred yards, I reach the Hospital and the Anatomical School, — a great convenience for me when the winter weather begins. One thing gives me great pleasure: from one of my windows the whole chain of the Tyrolean Alps is visible as far as Appenzell; and as the country is flat to their very base, I see them better than we see our Alps from the plain. It is a great pleasure to have at least a part of our Swiss mountains always in sight. To enjoy it the more, I have placed my table opposite the window, so that every time I lift my head my eyes rest on our dear country. This does not prevent me from feeling dull sometimes, especially when I am alone, but I hope this will pass off when my occupations become more regular. . . .

A far more stimulating intellectual life than that of Heidelberg awaited our students at Munich. Among their professors were some of the most original men of the day, — men whose influence was felt all over Europe. Döllinger lectured on comparative anatomy and kindred subjects; Martius and Zuccarini

on botany. Martius gave, besides, his so-called "Reise-Colleg," in which he instructed the students how to observe while on their travels. Schelling taught philosophy, the titles of his courses in the first term being, "Introduction to Philosophy" and "The Ages of the World"; in the second, "The Philosophy of Mythology" and "The Philosophy of Revelation." Schelling made a strong impression upon the friends. His manner was as persuasive as his style was clear, and his mode of developing his subject led his hearers along with a subtle power which did not permit fatigue. Oken lectured on general natural history, physiology, and zoölogy, including his famous views on the philosophy of nature (Natur-philosophie). His lectures gave occasion for much scientific discussion, the more so as he brought very startling hypotheses into his physiology, and drew from them conclusions which even upon his own showing were not always in accordance with experience. "On philosophical grounds," he was wont to say, when facts and theory thus confronted each other, "we must so accept it." Oken was extremely friendly with the students, and Agassiz, Braun, and Schimper (who joined them at Munich) passed an evening

once a week at his house, where they listened to scientific papers or discussed scientific matters, over a pipe and a glass of beer. They also met once a week to drink tea at the house of Professor von Martius, where, in like manner, the conversation turned upon scientific subjects, unless something interesting in general events gave it a different turn. Still more beloved was Döllinger, whose character they greatly esteemed and admired while they delighted in his instruction. Not only did they go to him daily, but he also came often to see them, bringing botanical specimens to Braun, or looking in upon Agassiz's breeding experiments, in which he took the liveliest interest, being always ready with advice or practical aid. The fact that Agassiz and Braun had their room in his house made intercourse with him especially easy. This room became the rendezvous of all the aspiring, active spirits among the young naturalists at Munich, and was known by the name of "The Little Academy." Schimper, no less than the other two, contributed to the vivid, enthusiastic intellectual life, which characterized their meetings. Not so happy as Agassiz and Braun in his later experience, the promise of his youth was equally brilliant;

and those who knew him in those early days remember his charm of mind and manner with delight. The friends gave lectures in turn on various subjects, especially on modes of development in plants and animals. These lectures were attended not only by students, but often by the professors.

Among Agassiz's intimate friends in Munich, beside those already mentioned, was Michahelles, the distinguished young zoölogist and physician, whose early death in Greece, where he went to practice medicine, was so much regretted. Like Agassiz, he was wont to turn his room into a menagerie, where he kept turtles and other animals, brought home, for the most part, from his journeys in Italy and elsewhere. Mahir, whose name occurs often in the letters of this period, was another college friend and fellow-student, though seemingly Agassiz's senior in standing, if not in years, for he gave him private instruction in mathematics, and also assisted him in his medical studies.

TO HIS SISTER CECILE.

MUNICH, *November* 20, 1827.

. . . I will tell you in detail how my time is spent, so that when you think of me you

may know where I am and what I am doing. In the morning from seven to nine I am at the Hospital. From nine to eleven I go to the Library, where I usually work at that time instead of going home. From eleven till one o'clock I have lectures, after which I dine, sometimes at one place, sometimes at another, for here every one, that is, every foreigner, takes his meals in the cafés, paying for the dinner on the spot, so that he is not obliged to go always to the same place. In the afternoon I have other lectures on various subjects, according to the days, from two or three till five o'clock. These ended, I take a walk although it is then dark. The environs of Munich are covered with snow, and the people have been going about in sleighs these three weeks. When I am frozen through I come home, and set to work to review my lectures of the day, or I write and read till eight or nine o'clock. Then I go to my café for supper. After supper I am glad to return to the house and go to bed.

This is the course of my daily life, with the single exception that sometimes Braun and I pass an evening with some professor, discussing with all our might and main subjects of which we often know nothing; this

does not, however, lessen the animation of the talk. More often, these gentlemen tell us of their travels, etc. I enjoy especially our visits to M. Martius, because he talks to us of his journey to Brazil, from which he returned some years ago, bringing magnificent collections, which he shows us whenever we call upon him. Friday is market day here, and I never miss going to see the fishes to increase my collection. I have already obtained several not to be found in Switzerland; and even in my short stay here I have had the good fortune to discover a new species, of which I have made a very exact description, to be printed in some journal of natural history. Were my dear Cecile here, I should have begged her to draw it nicely for me. That would have been pleasant indeed. Now I must ask a stranger to do it, and it will have by no means the same value in my eyes. . . .

TO HIS BROTHER AUGUSTE.

MUNICH, *December* 26, 1827.

. . . After my long fast from news of you, your letter made me very happy. I was dull besides, and needed something to cheer me. . . . Since my talk about natural history does not bore you, I want to tell you various

other things about it, and also to ask you to do me a favor. I have stuffed a superb otter lately; next week I shall receive a beaver, and I have exchanged all my little toads from Neuchâtel for reptiles from Brazil and Java. One of our professors here, who is publishing a natural history of reptiles, will introduce in his work my description of that species, and my observations upon it. He has already had lithographed those drawings of eggs that Cecile made for me, as well as the colored drawings made for me by Braun's sister when I was at Carlsruhe. My collection of fishes is also much increased, but I have no duplicates left of the species I brought with me. I have exchanged them all. I should therefore be greatly obliged if you would get me some more of the same. I will tell you what kinds I want, and how you are to forward them. I have still at Cudrefin several jars of thick green glass. When you go there take them away with you, fill them with alcohol, and put into them as many of these fishes as you can find for me. Put something between every two specimens, to prevent them from rubbing against each other; pack them in a little box wrapped in hay, and send them either by a good opportunity or in the least

expensive way. The kinds I want are [here follows the list]. . . . It will interest you to know that I am working with a young Dr. Born upon an anatomy and natural history of the fresh-water fishes of Europe. We have already gathered a great deal of material, and I think by the spring, or in the course of the summer, we shall be able to publish the first number. This will bring in a little ready money for a short journey in the vacation.

I earnestly advise you to while away your leisure hours with study. Read much, but only good and useful books. I promised to send you something; do not think, because I have not done so yet, that I have forgotten it. On the contrary, the difficulty of choosing is the cause of the delay; but I will make farther inquiry as to what will suit you best and you shall have my list. Meantime remember to read Say, and if you have not already begun it, do not put it off. Remember that statistical and political knowledge alone distinguishes the true merchant from the mere tradesman, and guides him in his undertakings. . . . A merchant familiar with the products of a country, its resources, its commercial and political relations with other countries, is much less likely to enter

into speculations based on false ideas, and therefore of doubtful issue. Write me about what you are reading and about your plans and projects, for I can hardly believe that any one could exist without forming them: I, at least, could not. . . .

The last line of this letter betrays the restless spirit of adventure growing out of the desire for larger fields of activity and research. Tranquilized for a while in the new and more satisfying intellectual life of Munich, it stirred afresh from time to time, not without arousing anxiety in friends at home, as we shall see. The letter to which the following is an answer has not been found.

FROM HIS MOTHER.

ORBE, *January* 8, 1828.

. . . Your letter reached me at Cudrefin, where I have been passing ten days. With what pleasure I received it, — and yet I read it with a certain sadness too, for there was something of ennui, I might say of discontent, in the tone. . . . Believe me, my dear Louis, your attitude is a wrong one; you see everything in shadow. Consider that you are exactly in the position you have chosen for

yourself; we have in no way opposed your plans. We have, on the contrary, entered into them with readiness, saying amen to your proposals, only insisting upon a profession that would make us easy about your future, persuaded as we are that you have too much energy and uprightness not to wish to fill honorably your place in society. You left us a few months ago with the assurance that two years would more than suffice to complete your medical studies. You chose the university which offered, as you thought, the most ample means to reach your end; and now, how is it that you look forward only with distaste to the practice of medicine? Have you reflected seriously before setting aside this profession? Indeed, we cannot consent to such a step. You would lose ground in our opinion, in that of your family, and in that of the public. You would pass for an inconsiderate, fickle young fellow, and the slightest stain on your reputation would be a mortal blow to us. There is one way of reconciling all difficulties, — the only one in my opinion. Complete your studies with all the zeal of which you are capable, and then, if you have still the same inclination, go on with your natural history; give yourself wholly up to it

should that be your wish. Having two strings to your bow, you will have the greater facility for establishing yourself. Such is your father's way of thinking as well as mine. . . . Nor are you made to live alone, my child. In a home only is true happiness to be found; there you can settle yourself to your liking. The sooner you have finished your studies, the sooner you can put up your tent, catch your blue butterfly, and metamorphose her into a loving housewife. Of course you will not gather roses without thorns; life consists of pains and pleasures everywhere. To do all the good you can to your fellow-beings, to have a pure conscience, to gain an honorable livelihood, to procure for yourself by work a little ease, to make those around you happy, — that is true happiness; all the rest but mere accessories and chimeras. . . .

TO HIS MOTHER.

MUNICH, *February* 3, 1828.

. . . You know well to whom you speak, dear mother, and how you must bait your hook in order that the fish may rise. When you paint it, I see nothing above domestic happiness, and am convinced that the height of felicity is to be found in the bosom of your

family, surrounded by little marmots to love and caress you. I hope, too, to enjoy this happiness in time. . . . But the man of letters should seek repose only when he has deserved it by his toil, for if once he anchor himself, farewell to energy and liberty, by which alone great minds are fostered. Therefore I have said to myself, that I would remain unmarried till my work should assure me a peaceful and happy future. A young man has too much vigor to bear confinement so soon; he gives up many pleasures which he might have had, and does not appreciate at their just value those which he has. As it is said that the *vaurien* must precede the *bon sujet*, so I believe that for the full enjoyment of sedentary life one must have played the vagabond for a while.

This brings me to the subject of my last letter. It seems that you have misunderstood me, for your answer grants me after all just what I ask. You think that I wish to renounce entirely the study of medicine? On the contrary, the idea has never occurred to me, and, according to my promise, you shall have one of these days a doctor of medicine as a son. What repels me is the thought of practicing medicine for a livelihood, and here

you give me free rein just where I wanted it. That is, you consent that I should devote myself wholly to the natural sciences should this career offer me, as I hope it may, a more favorable prospect. It requires, for instance, but two or three years to go around the world at government expense. I will levy contributions on all my senses that not a single chance may escape me for making interesting observations and fine collections, so that I also may be ranked among those who have enlarged the boundaries of science. With that my future is secured, and I shall return content and disposed to do all that you wish. Even then, if medicine had gained greater attraction for me, there would still be time to begin the practice of it. It seems to me there is nothing impracticable in this plan. I beg you to think of it, and to talk it over with papa and with my uncle at Lausanne. . . . I am perfectly well and as happy as possible, for I feed in clover here on my favorite studies, with every facility at my command. If you thought my New Year's letter depressed, it was only a momentary gloom due to the memories awakened by the day. . . .

FROM HIS FATHER.

ORBE, *February* 21, 1828.

Your mother's last letter, my dear Louis, was in answer to one from you which crossed it on the way, and gave us, so far as your health and contentment are concerned, great satisfaction. Yet our gratification lacks something; it would be more complete had you not a mania for rushing full gallop into the future. I have often reproved you for this, and you would fare better did you pay more attention to my reproof. If it be an incurable malady with you, at all events do not force your parents to share it. If it be absolutely essential to your happiness that you should break the ice of the two poles in order to find the hairs of a mammoth, or that you should dry your shirt in the sun of the tropics, at least wait till your trunk is packed and your passports are signed before you talk with us about it. Begin by reaching your first aim, a physician's and surgeon's diploma. I will not for the present hear of anything else, and that is more than enough. Talk to us, then in your letters, of your friends, of your personal life, of your wants (which I am always ready to satisfy), of your pleasures, of

your feeling for us, but do not put yourself out of our reach with your philosophical syllogisms. My own philosophy is to fulfill my duties in my sphere, and even that gives me more than I can do. . . .

The Vaudois "Society of Public Utility" has just announced an altogether new project, that of establishing popular libraries. A committee consisting of eight members, of whom I have the honor to be one, is nominated under the presidency of M. Delessert for the execution of this scheme. What do you think of the idea? To me it seems a delicate matter. I should say that before we insist upon making people read we must begin by preparing them to read usefully? . . .

TO HIS FATHER.

MUNICH, *March* 3, 1828.

. . . What you tell me of the "Society of Public Utility" has aroused in me a throng of ideas, about which I will write you when they are a little more mature. Meanwhile, please tell me: 1. What is this Society? 2. Of what persons is it composed? 3. What is its principal aim? 4. What are the popular libraries to contain, and for what class are they intended? I believe this project may be of

the greatest service to our people, and it is on this account that I desire farther details that I may think it over carefully. Tell me, also, in what way you propose to distribute your libraries at small expense, and how large they are to be. . . .

I could not be more satisfied than I am with my stay here. I lead a monotonous but an exceedingly pleasant life, withdrawn from the crowd of students and seeing them but little. When our lectures are over we meet in the evening at Braun's room or mine, with three or four intimate acquaintances, and talk of scientific matters, each one in his turn presenting a subject which is first developed by him, and then discussed by all. These exercises are very instructive. As my share, I have begun to give a course of natural history, or rather of pure zoölogy. Braun talks to us of botany, and another of our company, Mahir, who is an excellent fellow, teaches us mathematics and physics in his turn. In two months our friend Schimper, whom we left at Heidelberg, will join us, and he will then be our professor of philosophy. Thus we shall form a little university, instructing each other and at the same time learning what we teach more thoroughly, because we shall be obliged

to demonstrate it. Each session lasts two or three hours, during which the professor in charge retails his merchandise without aid of notes or book. You can imagine how useful this must be in preparing us to speak in public and with coherence; the experience is the more important, since we all desire nothing so much as sooner or later to become professors in very truth, after having played at professor in the university.

This brings me naturally to my projects again. Your letter made me feel so keenly the anxiety I had caused you by my passion for travel, that I will not recur to it; but as my object was to make in that way a name that would win for me a professorship, I venture upon another proposition. If during the course of my studies I succeed in making myself known by a work of distinction, will you not then consent that I shall study, at least during one year, the natural sciences alone, and then accept a professorship of natural history, with the understanding that in the first place, and in the time agreed upon, I shall take my Doctor's degree? This is, indeed, essential to my obtaining what I wish, at least in Germany. You will object that, before thinking of anything beyond, I ought first to

fulfill the condition. But let me say that the more clearly a man sees the road before him, the less likely he is to lose his way or take the wrong turn, — the better he can divide his stages and his resting-places. . . .

FROM HIS FATHER.

ORBE, *March* 25, 1828.

. . . I have had a long talk about you with your uncle. He does not at all disapprove of your letters, of which I told him the contents. He only insists, as we do, on the necessity of a settled profession as absolutely essential to your financial position. Indeed, the natural sciences, however sublime and attractive, offer nothing certain in the future. They may, no doubt, be your golden bridge, or you may, thanks to them, soar very high, but — modern Icarus — may not also some adverse fortune, an unexpected loss of popularity, or, perhaps, some revolution fatal to your philosophy, bring you down with a somersault, and then you would not be sorry to find in your quiver the means of gaining your bread. Agreed that you have now an invincible repugnance to the practice of medicine, it is evident from your last two letters that you would have no less objection to any

other profession by which money is to be made, and, besides, it is too late to make another selection. This being so, we will come to an understanding in one word: Let the sciences be the balloon in which you prepare to travel through higher regions, but let medicine and surgery be your parachutes. I think, my dear Louis, you cannot object to this way of looking at the question and deciding it. In making my respects to the professor of zoölogy, I have the pleasure to tell him that his uncle was delighted with his way of passing his evenings, and congratulates him with all his heart on his choice of a recreation. Enough of this chapter. I close it here, wishing you most heartily courage, health, success, and, above all, contentment. . . .

Upon this follows the answer to Louis's request for details about the "Society of Public Utility." It shows the intimate exchange of thought between father and son on educational subjects, but it is of too local an interest for reproduction here.

The Easter vacation was devoted to a short journey, some account of which will be found in the next letter. The traveling party consisted of Agassiz, Braun, and Schimper, with

two other students, who did not, however, remain with them during the whole trip.

TO HIS FATHER.

MUNICH, *May* 15, 1828.

. . . Pleasant as my Easter journey was, I will give you but a brief account of it, for my enjoyment was so connected with my special studies that the details would only be tiresome to you. You know who were my traveling companions, so I have only to tell you of our adventures, assuredly not those of knights errant or troubadours. Could these gentry have been resuscitated, and have seen us starting forth in blouses, with bags or botanical boxes at our backs and butterfly-nets in our hands, instead of lance and buckler, they could hardly have failed to look down upon us with pity from the height of their grandeur.

The first day brought us to Landshut, where was formerly the university till it was transferred, ten years ago, to Munich. We had the pleasure of finding along our road most of the early spring plants. The weather was magnificent, and nature seemed to smile upon her votaries. . . . We stopped on the way but one day, at Ratisbon, to visit some

relations of Braun's, with whom we promised to spend several days on our return. Learning on our arrival at Nüremberg that the Dürer festival, which had been our chief inducement for this journey, would not take place under eight or ten days, we decided to pass the intervening time at Erlangen, the seat, as you know, of a university. I do not know if I have already told you that among German students the exercise of hospitality toward those who exchange visits from one university to another is a sacred custom. It gives offense, or is at least looked upon as a mark of pride and disdain, if you do not avail yourself of this. We therefore went to one of the *cafés de réunion*, and received at once our tickets for lodgings. We passed six days at Erlangen most agreeably, making a botanical excursion every day. We also called upon the professors of botany and zoölogy, whom we had already seen at Munich, and by whom we were most cordially received. The professor of botany, M. Koch, invited us to a very excellent dinner, and gave us many rare plants not in our possession before, while M. Wagner was kind enough to show us in detail the Museum and the Library.

At last came the day appointed for the

third centennial festival of Dürer. Everything was so arranged as to make it very brilliant, and the weather was most favorable. I doubt if ever before were collected so many painters in the same place. They gathered, as if to vie with each other, from all nations, Russians, Italians, French, Germans, etc. Beside the pupils of the Academy of Fine Arts at Munich, I think that every soul who could paint, were it only the smallest sketch, was there to pay homage to the great master. All went in procession to the place where the monument is to be raised, and the magistrates of the city laid the first stones of the pedestal. To my amusement they cemented these first stones with a mortar which was served in great silver platters, and made of fine pounded porcelain mixed with champagne. In the evening all the streets were illuminated; there were balls, concerts, and plays, so that we must have been doubled or quadrupled to see everything. We stayed some days longer at Nüremberg to visit the other curiosities of the city, especially its beautiful churches, its manufactories, etc., and then started on our return to Ratisbon. . . .

CHAPTER III.

1828 – 1829 : ÆT. 21 – 22.

First Important Work in Natural History. — Spix's Brazilian Fishes. — Second Vacation Trip. — Sketch of Work during University Year. — Extracts from the Journal of Mr. Dinkel. — Home Letters. — Hope of joining Humboldt's Asiatic Expedition. — Diploma of Philosophy. — Completion of First Part of the Spix Fishes. — Letter concerning it from Cuvier.

It was not without a definite purpose that Agassiz had written to his father some weeks before, "Should I during the course of my studies succeed in making myself known by a distinguished work, would you not then consent that I should study for one year the natural sciences alone?" Unknown to his parents, for whom he hoped to prepare a delightful surprise, Agassiz had actually been engaged for months on the first work which gave him distinction in the scientific world; namely, a description of the Brazilian fishes brought home by Martius and Spix from their celebrated journey in Brazil. This was the secret to which allusion is made in the next

letter. To his disappointment an accident brought his undertaking to the knowledge of his father and mother before it was completed. He always had a boyish regret that his little plot had been betrayed before the moment for the denouement arrived. The book was written in Latin and dedicated to Cuvier.[1]

TO HIS BROTHER.

MUNICH, *July* 27, 1828.

. . . Various things which I have begun keep me a prisoner here. Probably I shall not stir during the vacation, and shall even give up the little trip in the Tyrol, which I had thought of making as a rest from occupations that bind me very closely at present, but from which I hope to free myself in the course of the holidays. Don't be angry with me for not telling you at once what they are. When you know, I hope to be forgiven for keeping you so long in the dark. I have kept it a secret from papa too, though in his last letter he asks me what is my especial work just now. A few months more of patience, and I will give you a strict account of

[1] *Selecta genera et species piscium quos collegit et pingendos curavit Dr. J. W. de Spix.* Digessit, descripsit et observationibus illustravit Dr. L. Agassiz.

my time since I came here, and then I am sure you will be satisfied with me. I only wish to guard against one thing: do not take it into your head that I am about to don the fool's cap suddenly and surprise you with a Doctor's degree; that would be going a little too fast, nor do I think of it yet. . . . I want to remind you not to let the summer pass without getting me fishes according to the list in my last letter, which I hope you have not mislaid. You would give me great pleasure by sending them as soon as possible. Let me tell you why. M. Cuvier has announced the publication of a complete work on all the known fishes, and in the prospectus he calls on such naturalists as occupy themselves with ichthyology to send him the fishes of the country where they live; he mentions those who have already sent him collections, and promises duplicates from the Paris Museum to those who will send him more. He names the countries also from which he has received contributions, and regrets that he has nothing from Bavaria. Now I possess several specimens of all the native species, and have even discovered some ten not hitherto known to occur here, beside one completely new to science, which I have named Cyprinus

uranoscopus on account of the position of the eyes, placed on the top instead of the sides of the head, — otherwise very like the gudgeon. I have therefore thought I could not better launch myself in the scientific world than by sending Cuvier my fishes with the observations I have made on their natural history. To these I should like to add such rare Swiss species as you can procure for me. So do not fail.

FROM HIS BROTHER.

NEUCHÂTEL, *August* 25, 1828.

. . . I received in good time, and with infinite delight, your pleasant letter of July 27th. Its mysteries have however been unveiled by Dr. Schinz, who came to the meeting of the Natural History Society in Lausanne, where he met papa and my uncle, to whom he pronounced the most solemn eulogiums on their son and nephew, telling them at the same time what was chiefly occupying you now. I congratulate you, my dear brother, but I confess that among us all I am the least surprised, for my presentiments about you outrun all this, and I hope soon to see them realized. In all frankness I can assure you that the stoutest antagonists of your natural history schemes begin to come

over to your side. Among them is my uncle here, who never speaks of you now but with enthusiasm. What more can be said? I gave him your letter to read, and since then he has asked me a dozen times at least if I had not forgotten to forward the remittance you asked for, saying that I must not delay it. The truth is, I have deferred writing till the last moment, because I have not succeeded in getting your fishes, and have always been hoping that I might be able to fulfill your commission. I busied myself on your behalf with all the zeal and industry of which I was capable, but quite in vain. The devil seemed to be in it. The season of Bondelles was over two months ago, and there are none to be seen; as to trout, I don't believe one has been eaten in the whole town for six weeks. I am forever at the heels of the fishermen, promising them double and treble the value of the fish I want, but they all tell me they catch nothing except pike. I have been to Cudrefin for lampreys, but found nothing. Rodolphe[1] has been paddling in the brook every day without success. I went to Sauge,— no eels, no anything but perch and a few little cat-fish. Two mortal Sundays did I spend, rod in hand, trying to

[1] An experienced old boatman.

catch bream, chubs, etc. I did get a few, but they were not worth sending. Now it is all over for this year, and we may as well put on mourning for them; but I promise you that as soon as the spring opens I will go to work, and you shall have all you want. If, in spite of everything, your hopes are not realized, I shall be very sorry, but rest assured that it is not my fault. . . .

TO HIS SISTER CECILE.

MUNICH, *October* 29, 1828.

. . . I have never written you about what has engrossed me so deeply; but since my secret is out, I ought not to keep silence longer. That you may understand why I have entered upon such a work I will go back to its origin. In 1817 the King of Bavaria sent two naturalists, M. Martius and M. Spix, on an exploring expedition to Brazil. Of M. Martius, with whom I always spend my Wednesday evenings, I have often spoken to you. In 1821 these gentlemen returned to their country laden with new discoveries, which they published in succession. M. Martius issued colored illustrations of all the unknown plants he had collected on his journey, while M. Spix brought out several folio volumes

on the monkeys, birds, and reptiles of Brazil, the animals being drawn and colored, chiefly life-size, by able artists. It had been his intention to give a complete natural history of Brazil, but to the sorrow of all naturalists he died in 1826. M. Martius, desirous to see the completion of the work which his traveling companion had begun, engaged a professor from Erlangen to publish the shells, and these appeared last year. When I came to Munich there remained only the fishes and insects, and M. Martius, who had learned something about me from the professors to whom I was known, found me worthy to continue the work of Spix, and asked me to carry on the natural history of the fishes. I hesitated for a long time to accept this honorable offer, fearing that the occupation might withdraw me too much from my studies; but, on the other hand, the opportunity for laying the foundation of a reputation by a large undertaking seemed too favorable to be refused. The first volume is already finished, and the printing was begun some weeks ago. You can imagine the pleasure I should have had in sending it to our dear father and mother before they had heard one word about it, or knew even of

the proposition. But I hope the premature disclosure of my secret (indeed, to tell the truth, I had not imposed silence on M. Schinz, not dreaming that he would see any one of the family) will not diminish your pleasure in receiving the first work of your brother Louis, which I hope to send you at Easter. Already forty colored folio plates are completed. Will it not seem strange when the largest and finest book in papa's library is one written by his Louis? Will it not be as good as to see his prescription at the apothecary's? It is true that this first effort will bring me in but little; nothing at all, in fact, because M. de Martius has assumed all the expenses, and will, of course, receive the profits. My share will be a few copies of the book, and these I shall give to the friends who have the first claim.

To his father Agassiz only writes of his work at this time: "I have been very busy this summer, and I can tell you from a good source (I have it from one of the professors himself) that the professors whose lectures I have attended have mentioned me more than once, as one of the most assiduous and best informed students of the university; saying

also that I deserved distinction. I do not tell you this from ostentation, but only that you may not think I lose my time, even though I occupy myself chiefly with the natural sciences. I hope yet to prove to you that with a brevet of Doctor as a guarantee, Natural History may be a man's bread-winner as well as the delight of his life." . . .

In September Agassiz allowed himself a short interruption of his work. The next letter gives some account of this second vacation trip.

TO HIS PARENTS.

MUNICH, *September* 26, 1828.

. . . The instruction for the academic year closed at the end of August, and our professors had hardly completed their lectures when I began my Alpine excursion. Braun, impatient to leave Munich, had already started the preceding day, promising to wait for me on the Salzburg road at the first spot which pleased him enough for a halt. That I might not keep him waiting, I begged a friend to drive me a good day's journey, thinking to overtake Braun the first day on the pleasant banks of the Lake of Chiem. My traveling companions were the younger Schimper [Wil-

helm], of whom I have spoken to you (and who made a botanical journey in the south of France and the Pyrenees two years ago), and Mahir, who drove us, with whom I am very intimate; he is a medical student, and also a very enthusiastic physicist. He gave me private lessons in mathematics all winter, and was a member of our philomathic meetings. Braun had not set out alone either, and his two traveling companions were also friends of ours. One was Trettenbacher, a medical student greatly given to sophisms and logic, but allowing himself to be beaten in argument with the utmost good nature, though always believing himself in the right; a thoroughly good fellow with all that, and a great connoisseur of antiquities. The other was a young student, Moré, from the ci-devant department of Mt. Tonnerre, who devotes himself entirely to the natural sciences, and has chosen the career of traveling naturalist. You can easily imagine that this attracts me to him, but as he is only a beginner I am, as it were, his mentor.

On the morning of our departure the weather was magnificent. Driving briskly along we had various surmises as to where we should probably meet our traveling com-

panions, not doubting that, as we hoped to reach the Lake of Chiem the same day, we should come across them the day following on one of its pretty islands. But in the afternoon the weather changed, and we were forced to seek shelter from torrents of rain at Rosenheim, a charming town on the banks of the Inn, where I saw for the first time this river of Helvetic origin. I saluted it as a countryman of mine, and wished I could change its course and send it back laden with my greetings. The next day Mahir drove us as far as the shore of the lake. There we parted from him, and took a boat to the islands, where we were much disappointed not to find Braun and his companions. We thought the bad weather of the day before (for here it had rained all day) might have obliged them to make the circuit of the lake. However, in order to overtake them before reaching Salzburg, we kept our boatmen, and were rowed across to the opposite shore near Grabenstadt, where we arrived at ten o'clock in the evening. In the afternoon the weather had cleared a little, and the view was beautiful as we pulled away from the islands and watched them fade in the twilight. I also gathered much interesting information about the in-

habitants of the waters of this lake. Among others, I was much pleased to find a cat-fish, taken in the lake by one of the island fishermen, and also a kind of chub, not found in Switzerland, and called by the fishermen here "Our Lady's Fish," because it occurs only on the shore of an island where there is a convent, the nuns of which esteem it a great delicacy.

The third day we reached Traunstein, where, although it was Sunday, there was a great horse fair. We looked with interest at the gay Tyroleans, with the cock-feathers in their pointed hats, singing and jödeling in the streets with their sweethearts on their arms. Every now and then they let fall some sarcastic comment on our accoutrements, which were indeed laughable enough to these people, who had never seen anything beyond their own chalets, and for whom an excursion from their mountains to a fair in the nearest town is a journey. It was noon when we stopped at Traunstein, and from there to Salzburg is but five leagues. Before reaching the fortress, however, you must pass the great custom-house on the Bavarian frontier, and fearing we might be delayed there too long by the stupid Austrian officials, and thus be pre-

vented from entering the city before the gates were closed, we resolved to wait till the next morning and spend the night at Adelstaetten, a pretty village about a league from Salzburg, and the last Bavarian post. Night was falling as we approached a little wood which hid the village from us. There we asked a peasant how far we had still to go, and when he had answered our question he told us, evidently with kind intention, that we should find good company in the village, for a few hours earlier three journeymen laborers had arrived there; and then he added that we should no doubt be glad to meet comrades and have a gay evening with them. We were not astonished to be taken for workmen, since every one who travels here on foot, with a knapsack on his back, is understood to belong to the laboring class. . . . Arrived at the village, we were delighted to find that the three journeymen were our traveling companions. They had come, like ourselves, from Traunstein, where we had missed each other in the crowd, and they were going likewise to sleep at Adelstaetten, to avoid the custom-house. Finally, on Monday, at ten o'clock, we crossed the long bridge over the Saala, between the white coats with yellow trimmings on guard there.

On the Bavarian frontier we had hardly remembered that there was a custom-house, and the name of student sufficed to pass us without our showing any passports; here, on the contrary, it was another reason for the strictest examination. "Have you no forbidden books?" was the first question. By good fortune, before crossing the bridge, I had advised Trettenbach to hide his song-book in the lining of his boot. I am assured that had it been taken upon him he would not have been allowed to pass. In ransacking Braun's bag, one of the officials found a shell such as are gathered by the basketful on the shores of the Lake of Neuchâtel. His first impulse was to go to the office and inquire whether we should not pay duty on this, saying that it was no doubt for the fabrication of false pearls, and we probably had plenty more. We had all the difficulty in the world to make him understand that not fifty steps from the custom-house the shores of the river were strewn with them. . . . After all this we had to empty our purses to show that we had money enough for our journey, and that we should not be forced to beg in order to get through. While we underwent this inquisition, another officer made a tour of inspection around us, to observe our general

bearing, etc. . . . After having kept us thus on coals for two hours they gave us back our passports, and we went our way. At one o'clock we arrived at Salzburg as hungry as wolves, but at the gate we had still to wait and give up our passports again in exchange for receipts, in virtue of which we could obtain permits from the police to remain in the city. From our inn, we sent a waiter to get these permits, but he presently returned with the news that we must go in person to take them; there was, however, no hurry; it would do in three or four hours! We had no farther difficulty except that it was made a condition of our stay that we should not appear in student's dress. This dress, they said, was forbidden in Austria. They begged Moré to have his hair cut, otherwise it would be shortened gratis, and also informed us that at our age it was not becoming to dispense with cravats. Happily, I had two with me, and Braun tied his handkerchief around his neck. It astonished me, also, to see that we were not entered on the list of strangers published every evening. So it was also, as we found, with other students, though the persons who came with them by the same conveyance, even the children, were duly inscribed. It seems this is a precaution against any gathering of students. . . .

The letter concludes in haste for the mail, and if the story of the journey was finished the final chapter has not been preserved. Some extracts from the home letters of Agassiz's friend Braun, which are in place here, throw light on their university life for the coming year.[1]

ALEXANDER BRAUN TO HIS FATHER.

MUNICH, *November* 18, 1828.

. . . I will tell you how we have laid out our time for this term. Our human consciousness may be said to begin at half-past five o'clock in the morning. The hour from six to seven is appointed for mathematics, namely, geometry and trigonometry. To this appointment we are faithful, unless the professor oversleeps himself, or Agassiz happens to have grown to his bed, an event which sometimes occurs at the opening of the term. From seven to eight we do as we like, including breakfast. Under Agassiz's new style of housekeeping the coffee is made in a machine which is devoted during the day to the soaking of all sorts of creatures for skeletons, and in the evening again to the brewing of our

[1] See *Life of Alexander Braun*, by his daughter, Madame Cecile Mettenius.

tea. At eight o'clock comes the clinical lecture of Ringseis. As Ringseis is introducing an entirely new medical system, this is not wholly without general physiological and philosophical interest. At ten o'clock Stahl lectures, five times a week, on mechanics as preliminary to physics. These and also the succeeding lectures, given only twice a week on the special natural history of amphibians by Wagler, we all attend together. From twelve to one o'clock we have nothing settled as yet, but we mean to take the lectures of Döllinger, in single chapters, as, for instance, when he comes to the organs of the senses. At one o'clock we go to dinner, for which we have at last found a comfortable and regular place, at a private house, after having dined everywhere and anywhere, at prices from nine to twenty kreutzers. Here, for thirteen kreutzers[1] each, in company with a few others, mostly known to us, we are provided with a good and neatly served meal. After dinner we go to Dr. Waltl, with whom we study chemistry, using Gmelin's text-book, and are shown the most important experiments. Next week we are to begin entomology with Dr. Perty, from three to four, three times a week.

[1] About nine cents of our money.

From one to two o'clock on Saturday we have a lesson in experimental physiology, plainly speaking, in animal dissection, from Dr. Oesterreicher, a young Docent, who has written on the circulation of the blood. As Agassiz dissects a great many animals, especially fishes, at the house, we are making rapid progress in comparative anatomy. At four o'clock we go usually once a week to hear Oken on "Natur-philosophie" (a course we attended last term also), but by that means we secure a good seat for Schelling's lecture immediately after. A man can hardly hear twice in his life a course of lectures so powerful as those Schelling is now giving on the philosophy of revelation. This will sound strangely to you, because, till now, men have not believed that revelation could be a subject for philosophical treatment; to some it has seemed too sacred; to others too irrational. . . . This lecture brings us to six o'clock, when the public courses are at an end: we go home, and now begin the private lectures. Sometimes Agassiz tries to beat French rules and constructions into our brains, or we have a lesson in anatomy, or I read general natural history aloud to William Schimper. By and by I shall review the natural history of grasses

and ferns, two families of which I made a special study last summer. Twice a week Karl Schimper lectures to us on the morphology of plants; a very interesting course on a subject but little known. He has twelve listeners. Agassiz is also to give us lectures occasionally on Sundays upon the natural history of fishes. You see there is enough to do. . . .

Somewhat before this, early in 1828, Agassiz had made the acquaintance of Mr. Joseph Dinkel, an artist. A day spent together in the country, in order that Mr. Dinkel might draw a brilliantly colored trout from life, under the immediate direction of the young naturalist, led to a relation which continued uninterruptedly for many years. Mr. Dinkel afterward accompanied Agassiz, as his artist, on repeated journeys, being constantly employed in making illustrations for the "Poissons Fossiles" and the "Poissons d'Eau Douce," as well as for his monographs and smaller papers. The two larger works, the latter of which remained unfinished, were even now in embryo. Not only was Mr. Dinkel at work upon the plates for the Fresh-Water Fishes, but Mr. J. C. Weber, who was then

engaged in making, under Agassiz's direction, the illustrations for the Spix Fishes, was also giving his spare hours to the same objects. Mr. Dinkel says of Agassiz's student life at this time:[1] —

"I soon found myself engaged four or five hours almost daily in painting for him fresh-water fishes from the life, while he was at my side, sometimes writing out his descriptions, sometimes directing me. . . . He never lost his temper, though often under great trial; he remained self-possessed and did everything calmly, having a friendly smile for every one and a helping hand for those who were in need. He was at that time scarcely twenty years old, and was already the most prominent among the students at Munich. They loved him, and had a high consideration for him. I had seen him at the Swiss students' club several times, and had observed him among the *jolly* students; he liked merry society, but he himself was in general reserved and never noisy. He picked out the gifted and highly-learned students, and would not waste his time

[1] Extract from notes written out in English by Mr. Dinkel after the death of Agassiz and sent to me. The English, though a little foreign, is so expressive that it would lose by any attempt to change it, and the writer will excuse me for inserting his vivid sketch just as it stands. — E. C. A.

in ordinary conversation. Often, when he saw a number of students going off on some empty pleasure-trip, he said to me, 'There they go with the other fellows; their motto is, "Ich gehe mit den andern." I will go my own way, Mr. Dinkel, — and not alone: I will be a leader of others.' In all his doings there was an ease and calm which was remarkable. His studio was a perfect German student's room. It was large, with several wide windows; the furniture consisted of a couch and about half a dozen chairs, beside some tables for the use of his artists and himself. Dr. Alex. Braun and Dr. Schimper lodged in the same house, and seemed to me to share his studio. Being botanists, they, too, brought home what they collected in their excursions, and all this found a place in the atelier, on the couch, on the seats, on the floors. Books filled the chairs, one alone being left for the other artist, while I occupied a standing desk with my drawing. No visitor could sit down, and sometimes there was little room to stand or move about. The walls were white, and diagrams were drawn on them, to which, by and by, we artists added skeletons and caricatures. In short, it was quite original. I was some time there before I could discover

the real names of his friends: each had a nickname, — Molluscus, Cyprinus, Rhubarb, etc."

From this glimpse into "The Little Academy" we return to the thread of the home letters, learning from the next one that Agassiz's private collections were assuming rather formidable proportions when considered as part of the household furniture. Brought together in various ways, partly by himself, partly in exchange for duplicates, partly as pay for arranging specimens in the Munich Museum, they had already acquired, when compared with his small means, a considerable pecuniary value, and a far higher scientific importance. They included fishes, some rare mammalia, reptiles, shells, birds, an herbarium of some three thousand species of plants collected by himself, and a small cabinet of minerals. After enumerating them in a letter to his parents he continues: "You can imagine that all these things are in my way now that I cannot attend to them, and that for want of room and care they are piled up and in danger of spoiling. You see by my list that the whole collection is valued at two hundred louis; and this is so low an estimate that even those who sell objects of natural his-

tory would not hesitate to take them at that price. You will therefore easily understand how anxious I am to keep them intact. Can you not find me a place where they might be spread out? I have thought that perhaps my uncle in Neuchâtel would have the kindness to let some large shelves be put up in the little upper room of his house in Cudrefin, where, far from being an annoyance or causing any smell, my collection, if placed in a case under glass, or disposed in some other suitable manner, would be an ornament. Be so kind as to propose it to him, and if he consents I will then tell you what I shall need for its arrangement. Remember that on this depends, in great part, the preservation of my specimens, and answer as soon as possible."

Agassiz was now hurrying forward both his preparation for his degree and the completion of his Brazilian Fishes, in the hope of at last fulfilling his longing for a journey of exploration. This hope is revealed in his next home letter. The letter is a long one, and the first half is omitted since it concerns only the arrangements for his collections, the care to be taken of them, etc.

TO HIS FATHER.

MUNICH, *February* 14, 1829.

. . . But now I must talk to you of more important things, not of what I possess, but of what I am to be. Let me first recall one or two points touched upon before in our correspondence, which should now be fully discussed.

1st. You remember that when I first left Switzerland I promised you to win the title of Doctor in two years, and to be prepared (after having completed my studies in Paris) to pass my examination before the "Conseil de Santé," and begin practice.

2d. You will not have forgotten either that you exacted this only that I might have a profession, and that you promised, should I be able to make my way in the career of letters and natural history, you would not oppose my wishes. I am indeed aware that in the latter case you see but one obstacle, that of absence from my country and separation from all who are dear to me. But you know me too well to think that I would voluntarily impose upon myself such an exile. Let us see whether we cannot resolve these difficulties to our mutual satisfaction, and consider what is

the surest road to the end I have proposed to myself ever since I began my medical studies. Weigh all my reasons, for in this my peace of mind and my future happiness are concerned. Examine my conduct with reference to what I propose in every light, that of son and Vaudois citizen included, and I feel sure you will concur in my views.

Here is my aim and the means by which I propose to carry it out. I wish it may be said of Louis Agassiz that he was the first naturalist of his time, a good citizen, and a good son, beloved of those who knew him. I feel within myself the strength of a whole generation to work toward this end, and I will reach it if the means are not wanting. Let us see in what these means consist. [Here follows the summing up of his reasons for preferring a professorship of natural history to the practice of medicine, and his intention of trying for a diploma as Doctor of Philosophy in Germany.] But how obtain a professorship, you will say, — that is the important point? I answer, the first step is to make myself a European name, and for that I am on the right road. In the first place my work on the fishes of Brazil, just about to appear, will make me favorably known. I

am sure it will be kindly received; for at the General Assembly of German naturalists and medical men last September, in Berlin, the part already finished and presented before the Assembly was praised in a manner for which I was quite unprepared. The professors also, to whom I was known, spoke of me there in very favorable terms.

In the second place there are now preparing two expeditions of natural history, one by M. de Humboldt, with whose reputation you are surely familiar, — the same who spent several years in exploring the equatorial regions of South America, in company with M. Bonpland. He has been for some years at Berlin, and is now about to start on a journey to the Ural Mountains, the Caucasus, and the confines of the Caspian Sea. Braun, Schimper, and I have been proposed to him as traveling companions by several of our professors; but the application may come too late, for M. de Humboldt decided upon this journey long ago, and has probably already chosen the naturalists who are to accompany him. How happy I should be to join this expedition to a country the climate of which is by no means unhealthy, under the direction of a man so generally esteemed, to whom the Em-

peror of Russia has promised help and an escort at all times and under all circumstances. The second expedition is to a country quite as salubrious, and which presents no dangers whatever for travelers, — South America. It will be under the direction of M. Ackermann, known as a distinguished agriculturist and as Councillor of State to the Grand Duke of Baden. I should prefer to go with Humboldt; but if I am too late, I feel very sure of being able to join the second expedition. So it depends, you see, only on your consent. This journey is to last two years, at the end of which time, happily at home once more, I can follow with all desirable facilities the career I have chosen. If there should be a place for me at Lausanne, which I should prefer to any other locality, I could devote my life to teaching my young countrymen, awaken in them the taste for science and observation so much neglected among us, and thus be more useful to my canton than I could be as a practitioner. These projects may not succeed; but in the present state of things all the probabilities are favorable. Therefore, I beg you to consider it seriously, to consult my uncle in Lausanne, and to write me at once what you think. . . .

In spite of the earnest desire for travel

shown in this letter it will be seen later how the restless aspirations of childhood, boyhood, and youth, which were, after all, only a latent love of research, crystallize into the concentrated purpose of the man who could remain for months shut up in his study, leaving his microscope only to eat and sleep, — a life as sedentary as ever was lived by a closet student.

FROM HIS FATHER.

ORBE, *February* 23, 1829.

. . . It was not without deep emotion that we read your letter of the 14th, and I easily understand that, anticipating its effect upon us all, you have deferred writing as long as possible. Yet you were wrong in so doing; had we known your projects earlier we might have forestalled for you the choice of M. de Humboldt, whose expedition seems to us preferable, in every respect, to that of M. Ackermann. The first embraces a wider field, and concerns the history of man rather than that of animals; the latter is confined to an excursion along the sea-board, where there would be, no doubt, a rich harvest for science, but much less for philosophy. However that may be, your father and mother, while they grieve for the day that will separate them from their

oldest son, will offer no obstacles to his projects, but pray God to bless them. . . .

The subjoined letter of about the same date from Alexander Braun to his father tells us how the projects so ardently urged upon his parents by Agassiz, and so affectionately accepted by them, first took form in the minds of the friends.

BRAUN TO HIS FATHER.

MUNICH, *February* 15, 1829.

. . . Last Thursday we were at Oken's. There was interesting talk on all sorts of subjects, bringing us gradually to the Ural and then to Humboldt's journey, and finally Oken asked if we would not like to go with Humboldt. To this we gave warm assent, and told him that if he could bring it about we would be ready to start at a day's notice, and Agassiz added, eagerly, "Yes, — and if there were any hope that he would take us, a word from you would have more weight than anything." Oken's answer gave us but cold comfort; nevertheless, he promised to write at once to Humboldt in our behalf. With this, we went home in great glee; it was very late and a bright moonlight night. Agassiz rolled

himself in the snow for joy, and we agreed that however little hope there might be of our joining the expedition, still the fact that Humboldt would hear of us in this way was worth something, even if it were only that we might be able to say to him one of these days, "We are the fellows whose company you rejected."

With this hope the friends were obliged to content themselves, for after a few weeks of alternate encouragement and despondency their bright vision faded. Oken fulfilled his promise and wrote to Humboldt, recommending them most warmly. Humboldt answered that his plans were conclusively settled, and that he had chosen the only assistants who were to accompany him, — Ehrenberg and Rose.

In connection with this frustrated plan is here given the rough draft of a letter from Agassiz to Cuvier, written evidently at a somewhat earlier date. Although a mere fragment, it is the outpouring of the same passionate desire for a purely scientific life, and shows that the opportunity suggested by Humboldt's journey had only given a definite aim to projects already full grown. From the contents it must have been written in 1828. After

some account of his early studies, which would be mere repetition here, he goes on: "Before finishing my letter, allow me to ask some advice from you, whom I revere as a father, and whose works have been till now my only guide. Five years ago I was sent to the medical school at Zurich. After the first few lectures there in anatomy and zoölogy I could think of nothing but skeletons. In a short time I had learned to dissect, and had made for myself a small collection of skulls of animals from different classes. I passed two years in Zurich, studying whatever I could find in the Museum, and dissecting all the animals I could procure. I even sent to Berlin at this time for a monkey in spirits of wine, that I might compare the nervous system with that of man. I spent all the little means I had in order to see and learn as much as possible. Then I persuaded my father to let me go to Heidelberg, where for a year I followed Tiedemann's courses in human anatomy. I passed almost the whole winter in the anatomical laboratory. The following summer I attended the lectures of Leuckart on zoölogy, and those of Bronn on fossils. When at Zurich, the longing to travel some day as a naturalist had taken possession of me, and at Heidelberg this desire

only increased. My frequent visits to the Museum at Frankfort, and what I heard there concerning M. Rüppell himself, strengthened my purpose even more than all I had previously read. I was, as it were, Rüppell's traveling companion: the activity, the difficulties to be overcome, all were present to me as I looked upon the treasures he had brought together from the deserts of Africa. The vision of difficulty thus vanquished, and of the inward satisfaction arising from it, tended to give all my studies a direction in keeping with my projects.

"I felt that to reach my aim more surely it was important to complete my medical studies, and for this I came to Munich eighteen months ago. Still I could not make up my mind to renounce the natural sciences. I attended some of the pathological lectures, but I soon found that I was neglecting them; and yielding once more to my inclination, I followed consecutively the lectures of Döllinger on comparative anatomy, those of Oken on natural history, those of Fuchs on mineralogy, as well as the courses of astronomy, physics, chemistry, and mathematics. I was confirmed in this withdrawal from medical studies by the proposition of M. de Martius

that I should describe the fishes brought back by Spix from Brazil, and to this I consented the more gladly because ichthyology has always been a favorite study with me. I have not, however, been able to give them all the care I could have wished, for M. de Martius, anxious to complete the publication of these works, has urged upon me a rapid execution. I hope, nevertheless, that I have made no gross errors, and I am the less likely to have done so, because I had as my guide the observations you had kindly made for him on the plates of Spix. Several of these plates were not very exact; they have been set aside and new drawings made. I beg that you will judge this work when it reaches you with indulgence, as the first literary essay of a young man. I hope to complete it in the course of the next summer. I would beg you, in advance, to give me a paternal word of advice as to the direction my studies should then take. Ought I to devote myself to the study of medicine? I have no fortune, it is true; but I would gladly sacrifice my life if, by so doing, I could serve the cause of science. Though I have not even a presentiment of any means with which I may one day travel in distant countries, I have, nevertheless, prepared

myself during the last three years as if I might be off at any minute. I have learned to skin all sorts of animals, even very large ones. I have made more than a hundred skeletons of quadrupeds, birds, reptiles, and fishes; I have tested all the various liquors for preserving such animals as should not be skinned, and have thought of the means of supplying the want in countries where the like preparations are not to be had, in case of need. Finally, I have trained as traveling companion a young friend,[1] and awakened in him the same love of the natural sciences. He is an excellent hunter, and at my instigation has been taking lessons in drawing, so that he is now able to sketch from nature such objects as may be desirable. We often pass delightful moments in our imaginary travels through unknown countries, building thus our castles in Spain. Pardon me if I talk to you of projects which at first sight seem puerile; only a fixed aim is needed to give them reality, and to you I come for counsel. My longing is so great that I feel the need of expressing it to some one who will understand me, and your sympathy would make me the happiest of mortals. I am so pursued by this thought of a scientific

[1] William Schimper, brother of Karl.

journey that it presents itself under a thousand forms, and all that I undertake looks toward one end. I have for six months frequented a blacksmith's and carpenter's shop, learning to handle hammer and axe, and I also practice arms, the bayonet and sabre exercise. I am strong and robust, know how to swim, and do not fear forced marches. I have, when botanizing and geologizing, walked my twelve or fifteen leagues a day for eight days in succession, carrying on my back a heavy bag loaded with plants or minerals. In one word, I seem to myself made to be a traveling naturalist. I only need to regulate the impetuosity which carries me away. I beg you, then, to be my guide."

The unfinished letter closes abruptly, having neither signature nor address. Perhaps the writer's courage failed him and it never was sent. An old letter (date 1827) from Cuvier to Martius, found among Agassiz's papers of this time, and containing the very notes on the Spix Fishes to which allusion is here made, leaves no doubt, however, that this appeal was intended for the great master who exercised so powerful an influence upon Agassiz throughout his whole life.

In the spring of 1829 Agassiz took his

diploma in the faculty of philosophy. He did this with no idea of making it a substitute for his medical degree, but partly in deference to Martius, who wished the name of his young colleague to appear on the title-page of the Brazilian Fishes with the dignity of Doctor, and partly because he believed it would strengthen his chance of a future professorship. Of his experience on this occasion he gives some account in the following letter: —

TO HIS BROTHER.

MUNICH, *May* 22, 1829.

. . . As it was necessary for me to go through with my examination at once, and as the days for promotion here were already engaged two months in advance, I decided to pass it at Erlangen. That I might not go alone, and also for the pleasure of their company, I persuaded Schimper and Michahelles to do the same. Braun wanted to be of the party, but afterward decided to wait awhile. We made our request to the Faculty in a long Latin letter (because, you know, among savants it is the thing to speak and write the language you know least), requesting permission to pass our examination in writing, and to go to Erlangen only for the colloquium and

promotion. They granted our request on condition of our promise (jurisjurandi loco polliciti sumus) to answer the questions propounded without help from any one and without consulting books. Among other things I had to develop a natural system of zoölogy, to show the relation between human history and natural history, to determine the true basis and limits of the philosophy of nature, etc. As an inaugural dissertation, I presented some general and novel considerations on the formation of the skeleton throughout the animal kingdom, from the infusoria, mollusks, and insects to the vertebrates, properly so called. The examiners were sufficiently satisfied with my answers to give me my degree the 23d or 24th of April, without waiting for the colloquium and promotion, writing to me that they were satisfied with my examination, and therefore forwarded my diploma without regard to the oral examination. . . . The Dean of the Faculty, in inclosing it to me, added that he hoped before long to see me professor, and no less the ornament of my university in that position than I had hitherto been as student. I must try not to disappoint him. . . .

A letter from his brother contains a few lines in reference to this. "Last evening, dear Louis, your two diplomas reached me. I congratulate you with all my heart on your success. I am going to send to grandpapa the one destined for him, and I see in advance all his pleasure, though it would be greater if the word medicine stood for that of philosophy."

The first part of the work on the Brazilian Fishes was now completed, and he had the pleasure of sending it to his parents as his own forerunner. After joining a scientific meeting to be held at Heidelberg, in September, he was to pass a month at home before returning to Munich for the completion of his medical studies.

TO HIS PARENTS.

MUNICH, *July* 4, 1829.

. . . I hope when you read this letter you will have received the first part of my Brazilian Fishes from M. ——, of Geneva, to whom Martius had to send a package of plants, with which my book was inclosed. I venture to think that this work will give me a name, and I await with impatience the criticism that I suppose it will receive from Cu-

vier. . . . I think the best way of reaching the various aims I have in view is to continue the career on which I have started, and to publish as soon as possible my natural history of the fresh-water fishes of Germany and Switzerland. I propose to issue it in numbers, each containing twelve colored plates accompanied by six sheets of letter-press. . . . In the middle of September there is to be a meeting of all the naturalists and medical men of Germany, to which foreign savants are invited. A similar meeting has been held for the last two or three years in one or another of the brilliant centres of Germany. This year it will take place at Heidelberg. Could one desire a better occasion to make known a projected work? I could even show the original drawings already made of species only found in the environs of Munich, and, so to speak, unknown to naturalists. At Heidelberg will be assembled Englishmen, Danes, Swedes, Russians, and even Italians. If I could before then arrange everything and distribute the printed circulars of my work I should be sure of success. . . .

In those days of costly postage one sheet of writing paper was sometimes made to serve for several members of the family. The next

crowded letter contains chiefly domestic details, but closes with a postscript from Mme. Agassiz, filling, as she says, the only remaining corner, and expressing her delight in his diploma and in the completion of his book.

FROM HIS MOTHER.

August 16, 1829.

. . . The place your brother has left me seems very insufficient for all that I have to say, dear Louis, but I will begin by thanking you for the happiness, as sweet as it is deeply felt, which your success has given us. Already our satisfaction becomes the reward of your efforts. We wait with impatience for the moment when we shall see you and talk with you. Your correspondence leaves many blanks, and we are sometimes quite ashamed that we have so few details to give about your book. You will be surprised that it has not yet reached us. Does the gentleman in Geneva intend to read it before sending it to us, or has he perhaps not received the package? Not hearing we are uneasy. . . . Good-by, my dear son; I have no room for more, except to add my tender love for you. An honorable mention of your name in the Lausanne Gazette has brought us many pleasant congratulations. . . .

TO HIS FATHER.

August, 1829.

. . . I hope by this time you have my book. I can the less explain the delay since M. Cuvier, to whom I sent it in the same way, has acknowledged its arrival. I inclose his letter, hoping it will give you pleasure to read what one of the greatest naturalists of the age writes me about it.

CUVIER TO LOUIS AGASSIZ.

PARIS, AU JARDIN DU ROI, *August* 3, 1829.

. . . You and M. de Martius have done me honor in placing my name at the head of a work so admirable as the one you have just published. The importance and the rarity of the species therein described, as well as the beauty of the figures, will make the work an important one in ichthyology, and nothing could heighten its value more than the accuracy of your descriptions. It will be of the greatest use to me in my History of Fishes. I had already referred to the plates in the second edition of my "Régne Animal." I shall do all in my power to accelerate the sale among amateurs, either by showing it to such as meet at my house or by calling attention to it in scientific journals.

I look with great interest for your history of the fishes of the Alps. It cannot but fill a wide gap in that portion of natural history, — above all, in the different divisions of the genus Salmo. The figures of Bloch, those of Meidinger, and those of Marsigli, are quite insufficient. We have the greater part of the species here, so that it will be easy for me to verify the characters; but only an artist, working on the spot, with specimens fresh from the water, can secure the colors. You will, no doubt, have much to add also respecting the development, habits, and use of all these fishes. Perhaps you would do well to limit yourself at first to a monograph of the Salmones.

With my thanks for the promised documents, accept the assurance of my warm regard and very sincere attachment.

B. G. Cuvier.

At last comes the moment, so long anticipated, when the young naturalist's first book is in the hands of his parents. The news of its reception is given in a short and hurried note.

FROM HIS FATHER.

ORBE, *August* 31, 1829.

I hasten, my dear son, to announce the arrival of your beautiful work, which reached us on Thursday, from Geneva. I have no terms in which to express the pleasure it has given me. In two words, for I have only a moment to myself, I repeat my urgent entreaty that you would hasten your return as much as possible. . . . The old father, who waits for you with open heart and arms, sends you the most tender greeting. . . .

CHAPTER IV.

1829 - 1830 : ÆT. 22 - 23.

Scientific Meeting at Heidelberg. — Visit at Home. — Illness and Death of his Grandfather. — Return to Munich. — Plans for Future Scientific Publications. — Takes his Degree of Medicine. — Visit to Vienna. — Return to Munich. — Home Letters. — Last Days at Munich. — Autobiographical Review of School and University Life.

TO HIS PARENTS.

HEIDELBERG, *September* 25, 1829.

. . . THE time of our meeting is almost at hand. Relieved from all anxiety about the subjects I had wished to present here, I can now be quietly with you and enjoy the rest and freedom I have so long needed. The tension of mind, forced upon me by the effort to reach my goal in time, has crowded out the thoughts which are most present when I am at peace. I will not talk to you of what I have been doing lately, (a short letter from Frankfort will have put you on my track), nor of the relations I have formed at the Heidelberg meeting, nor of the manner in which

I have been received, etc. These are matters better told than written. . . . I intend to leave here to-morrow or the day after, according to circumstances. I shall stay some days at Carlsruhe to put my affairs in order, and from there make the journey home as quickly as possible. . . .

The following month we find him once more at home in the parsonage of Orbe. After the first pleasure and excitement of return, his time was chiefly spent in arranging his collections at Cudrefin, where his grandfather had given him house-room for them. In this work he had the help of the family in general, who made a sort of scientific fête of the occasion. But it ended sadly with the illness and death of the kind old grandfather, under whose roof children and grandchildren had been wont to assemble.

AGASSIZ TO BRAUN.

ORBE, *December* 3, 1829.

. . . I will devote an hour of this last evening I am to pass in Orbe, to talking with you. You will wonder that I am still here, and that I have not written. You already know that I have been arranging my collections at Cudre-

fin, and spending very happy days with my grandfather. But he is now very ill, and even should we have better news of him to-day, the thought weighs heavily on my heart, that I must take leave of him when he is perhaps on his death-bed. . . . I have just tied up my last package of plants, and there lies my whole herbarium in order, — thirty packages in all. For this I have to thank you, dear Alex., and it gives me pleasure to tell you so and to be reminded of it. What a succession of glorious memories came up to me as I turned them over. Free from all disturbing incidents, I enjoyed anew our life together, and even more, if possible, than in actual experience. Every talk, every walk, was present to me again, and in reviewing it all I saw how our minds had been drawn to each other in an ever-strengthening union. In you I see my own intellectual development reflected as in a mirror, for to you, and to my intercourse with you, I owe my entrance upon this path of the noblest and most lasting enjoyment. It is delightful to look back on such a past with the future so bright before us. . . .

Agassiz now returned to Munich to add the title of Doctor of Medicine to that of Doctor

of Philosophy. A case of somnambulism, which fell under his observation and showed him disease, or, at least, abnormal action of the brain, under an aspect which was new to him, seems to have given a fresh impulse to his medical studies, and, for a time, he was inclined to believe that the vocation which had thus far been to him one of necessity, might become one of preference. But the naturalist was stronger than the physician. During this very winter, when he was preparing himself with new earnestness for his profession, a collection of fossil fishes was put into his hands by the Director of the Museum of Munich. It will be seen with what ardor he threw himself into this new investigation. His work on the "Poissons Fossiles," which placed him in a few years in the front rank of European scientific men, took form at once in his fertile brain.

TO HIS BROTHER.

MUNICH, *January* 18, 1830.

. . . My resolve to study medicine is now confirmed. I feel all that may be done to rènder this study worthy the name of science, which it has so long usurped. Its intimate alliance with the natural sciences and the enlightenment it promises me regarding them

are indeed my chief incitements to persevere in my resolution. In order to gain time, and to strike while the iron is hot (don't be afraid it will grow cold; the wood which feeds the fire is good), I have proposed to Euler, with whom I am very intimate, to review the medical course with me. Since then, we pass all our evenings together, and rarely separate before midnight, — reading alternately French and German medical books. In this way, although I devote my whole day to my own work about fishes, I hope to finish my professional studies before summer. I shall then pass my examination for the Doctorate in Germany, and afterward do the same in Lausanne. I hope that this decision will please mama. My character and conduct are the pledge of its accomplishment.

This, then, is my night-work. I have still to tell you what I do by day, and this is more important. My first duty is to complete my Brazilian Fishes. To be sure, it is only an honorary work, but it must be finished, and is an additional means of making subsequent works profitable. This is my morning occupation, and I am sure of bringing it to a close about Easter. After much reflection, I have decided that the best way to turn my Fresh-

Water Fishes to account, is to finish them completely before offering them to a publisher. All the expenses being then paid, I could afford, if the first publisher should not feel able to take them on my own terms, to keep them as a safe investment. The publisher himself seeing the material finished, and being sure of bringing it out as a complete work, the value of which he can on that account better estimate, will be more disposed to accept my proposals, while I, on my side, can be more exacting. The text for this I write in the afternoon. My greatest difficulty at first was the execution of the plates. But here, also, my good star has served me wonderfully. I told you that beside the complete drawings of the fishes I wanted to represent their skeletons and the anatomy of the soft parts, which has never been done for this class. I shall thereby give a new value to the work, and make it desirable for all who study comparative anatomy. The puzzle was to find some one who was prepared to draw things of this kind; but I have made the luckiest hit, and am more than satisfied. My former artist continues to draw the fishes, a second draws the skeletons (one who had already been engaged for several years in the same way, for a work

upon reptiles), while a young physician, who is an admirable draughtsman, makes my anatomical figures. For my share, I direct their work while writing the text, and thus the whole advances with great strides. I do not, however, stop here. Having by permission of the Director of the Museum one of the finest collections of fossils in Germany at my dis position, and being also allowed to take the specimens home as I need them, I have undertaken to publish the ichthyological part of the collection. Since it only makes the difference of one or two people more to direct, I have these specimens also drawn at the same time. Nowhere so well as here, where the Academy of Fine Arts brings together so many draughtsmen, could I have the same facility for completing a similar work; and as it is an entirely new branch, in which no one has as yet done anything of importance, I feel sure of success; the more so because Cuvier, who alone could do it (for the simple reason that every one else has till now neglected the fishes), is not engaged upon it. Add to this that just now there is a real need of this work for the determination of the different geological formations. Once before, at the Heidelberg meeting, it had been proposed to me; the

Director of the Mines at Strasbourg, M. Voltz, even offered to send me at Munich the whole collection of fossil fishes from their Museum. I did not speak to you of this at the time because it would have been of no use. But now that I have it in my power to carry out the project, I should be a fool to let a chance escape me which certainly will not present itself a second time so favorably. It is therefore my intention to prepare a general work on fossil ichthyology. I hope, if I can command another hundred louis, to complete everything of which I have spoken before the end of the summer, that is to say, in July. I shall then have on hand two works which should surely be worth a thousand louis to me. This is a low estimate, for even ephemeral pieces and literary ventures are paid at this price. You can easily make the calculation. They allow three louis for each plate with the accompanying text; my fossils will have about two hundred plates, and my fresh-water fishes about one hundred and fifty. This seems to me plausible. . . .

This letter evidently made a favorable impression on the business heads of the family at Neuchâtel, for it is forwarded to his par-

ents, with these words from his brother on the last sheet: "I hasten, dear father, to send you this excellent letter from my brother, which has just reached me. They have read it here with interest, and Uncle François Mayor, especially, sees both stability and a sound basis in his projects and enterprises."

There is something touching and almost amusing in Agassiz's efforts to give a prudential aspect to his large scientific schemes. He was perfectly sincere in this, but to the end of his life he skirted the edge of the precipice, daring all, and finding in himself the power to justify his risks by his successes. He was of frugal personal habits; at this very time, when he was keeping two or three artists on his slender means, he made his own breakfast in his room, and dined for a few cents a day at the cheapest eating houses. But where science was concerned the only economy he recognized, either in youth or old age, was that of an expenditure as bold as it was carefully considered.

In the above letter to his brother we have the story of his work during the whole winter of 1830. That his medical studies did not suffer from the fact that, in conjunction with them, he was carrying on his two great works

on the living and the dead world of fishes may be inferred from the following account of his medical theses. It was written after his death, to his son Alexander Agassiz, by Professor von Siebold, now Director of the Museum in the University of Munich. "How earnestly Agassiz devoted himself to the study of medicine is shown by the theses (seventy-four in number), a list of which was printed, according to the prescribed rule and custom, with his 'Einladung.' I am astonished at the great number of these. The subjects are anatomical, pathological, surgical, obstetrical; they are inquiries into materia medica, medicina forensis, and the relation of botany to these topics. One of them interested me especially. It read as follows. 'Foemina humana superior mare.' I would gladly have known how your father interpreted that sentence. Last fall (1873) I wrote him a letter, the last I ever addressed to him, questioning him about this very subject. That letter, alas! remained unanswered."

In a letter to his brother just before taking his degree, Agassiz says: "I am now determined to pursue medicine and natural history side by side. Thank you, with all my heart, for your disinterested offer, but I shall not

need it, for I am going on well with my publisher, M. Cotta, of Stuttgart. I have great hope that he will accept my works, since he has desired that they should be forwarded to him for examination. I have sent him the whole, and I feel very sure he will swallow the pill. My conditions would be the only cause of delay, but I hope he will agree to them. For the fresh-water fishes and the fossils together I have asked twenty thousand Swiss francs. Should he not consent to this, I shall apply to another publisher."

On the 3d of April he received his degree of Doctor of Medicine. A day or two later he writes to his mother that her great desire for him is accomplished.

TO HIS MOTHER.

MUNICH, *April*, 1830.

. . . My letter to-day must be to you, for to you I owe it that I have undertaken the work just completed, and I write to thank you for having encouraged my zeal. I am very sure that no letter from me has ever given you greater pleasure than this one will bring; and I can truly say, on my own part, that I have never written one with greater satisfaction. Yesterday I finished my medical ex-

amination, after having satisfied every requirement of the Faculty. . . . The whole ceremony lasted nine days. At the close, while they considered my case, I was sent out of the room. On my return, the Dean said to me, "The Faculty have been *very much*" (emphasized) "pleased with your answers; they congratulate themselves on being able to give the diploma to a young man who has already acquired so honorable a reputation. On Saturday, after having argued your thesis, you will receive your degree, in the Academic Hall, from the Rector of the University." The Rector then added that he should look upon it as the brightest moment of his Rectorship when he conferred upon me the title I had so well merited. Next Saturday, then, at the very time you receive this letter, at ten o'clock in the morning, the discussion will have begun, and at twelve I shall have my degree. Dear Mother, dismiss all anxiety about me. You see I am as good as my word. . . . Write soon; in a few days I go to Vienna for some months. . . .

FROM HIS MOTHER.

ORBE, *April* 7, 1830.

I cannot thank you enough, my dear Louis, for the happiness you have given me in completing your medical examinations, and thus securing to yourself a career as safe as it is honorable. It is a laurel added to those you have already won; in my eyes the most precious of all. You have for my sake gone through a long and arduous task; were it in my power I would gladly reward you, but I cannot even say that I love you the more for it, because that is impossible. My anxious solicitude for your future is a proof of my ardent affection for you; only one thing was wanting to make me the happiest of mothers, and this, my Louis, you have just given me. May God reward you by giving you all possible success in the care of your fellow-beings. May the benedictions which honor the memory of a good physician be your portion, as they have been in the highest degree that of your grandfather. Why can he not be here to share my happiness to-day in seeing my Louis a medical graduate! . . .

Agassiz was recalled from Vienna in less

than two months by the arrival in Munich of his publisher, M. Cotta, a personal interview with whom seemed to him important. The only letter preserved from the Vienna visit shows that his short stay there was full of interest and instruction.

TO HIS FATHER.

VIENNA, *May* 11, 1830.

. . . Since my arrival I have seen so much that I hardly know where to begin my narrative, and what I have seen has suggested reflections on many grave subjects, of a kind I had hardly expected to make here. Nowhere have I seen establishments on broader or more stately foundations, nor do I believe that anywhere are foreigners allowed more liberal use of like institutions. I speak of the university, the hospitals, libraries, and collections of all sorts. Neither have I seen anywhere else such fine churches, and I have more than once felt the difference between worshiping within bare walls, and in buildings more worthy of devotional purposes. In one word, I should be enchanted with my stay in Vienna if I could be free from the idea that I am always surrounded by an imperceptible net, ready to close upon me at the slightest signal. With

this exception, the only discomfort to a foreigner here, if he is unaccustomed to it, is that of being obliged to abstain from all criticism of affairs in public places; still more must he avoid commenting upon persons. I am especially satisfied with my visit from a scientific point of view. I have learned, and am still learning, the care of the eyes and how to operate upon them; as to medicine, the physicians, however good, do not surpass those I have already known; and as I do not believe it important that a young physician should familiarize himself with a great variety of curative methods, I try to observe carefully the patient and his disease rather than to remember the medicaments applied in special cases. Surgery and midwifery are poorly provided, but one has a chance to see many interesting cases.

During the last fortnight I have visited the collection of natural history often, generally in the afternoon. To tell you how I have been expected there from the moment I was known to be here, and how I was received on my first visit, and have been fêted since (as Ichthyologus primus seculi, — so they say), would, perhaps, tire you and might seem egotistical in me, neither of which do I desire.

But it will not be indifferent to you to know that Cotta is disposed to accept my Fishes. He has been at Munich for some days, and Schimper has been talking with him, and has advanced matters more by a few words than I had been able to do by much writing. For this reason I intend returning soon to Munich to complete the business, since Cotta is to be there several weeks longer. Thus I shall have reached my aim, and be provided from this autumn onward with an independent maintenance. I was often very anxious this past winter, in my uncertainty about the means of finally making good such large outlays. If, however, Cotta makes no other condition than that of a certain number of subscribers, I shall be sure of them in six months. You may thus regard what I have done as a speculation happily concluded, and one which places me at the summit of my desires, for it leaves me free, at last, to work upon my projects. . . .

A letter to his brother, of the 29th of May, just after his return to Munich, gives a retrospect of the Viennese visit, including the personal details which he had hesitated to write to his father. They are important as showing

the position he already, at twenty-three years of age, held among scientific men. "Everything," he says, "was open to me as a foreigner, and to my great surprise I was received as an associate already known. Was it not gratifying to go to Vienna with no recommendation whatever, and to be welcomed and sought by all the scientific men, and afterwards presented and introduced everywhere? In the Museum, not only were the rooms opened for me when I pleased, but also the cases, and even the jars, so that I could take out whatever I needed for examination. At the hospital several professors carried their kindness so far, as to invite me to accompany them in their private visits. You may fancy whether I profited by all this, and how many things I saw." After some account of his business arrangements with Cotta, he adds: "Meantime, be at ease about me. I have strings enough to my bow, and need not feel anxious about the future. What troubles me is that the thing I most desire seems to me, at least for the present, farthest from my reach, — namely, the direction of a great Museum. When I have finished with Cotta I shall begin to pack my effects, and shall hope to turn my face homeward somewhere about the end of August. I can

hardly leave earlier, because, for the sake of practice, I have begun to deliver zoölogical lectures, open to all who like to attend, and I want to complete the course before my departure. I lecture without even an outline or headings before me, but this requires preparation. You see I do not lose my time."

The next home letter announces an important change in the family affairs. His father had been called from his parish at Orbe to that of Concise, a small town situated on the southwestern shore of the Lake of Neuchâtel.

FROM HIS MOTHER.

ORBE, *July*, 1830.

. . . Since your father wrote you on the 4th of June, dear Louis, we have had no news from you, and therefore infer that you are working with especial zeal to wind up your affairs in Germany and come home as soon as possible. Whatever haste you make, however, you will not find us here. Four days ago your father became pastor of Concise, and yesterday we went to visit our new home. Nothing can be prettier, and by all who know the place it is considered the most desirable position in the canton. There is a vineyard, a fine orchard filled with fruit-trees in full bear

ing, and an excellent kitchen garden. A never-failing spring gushes from a grotto, and within fifty steps of the house is a pretty winding stream with a walk along the bank, bordered by shrubbery, and furnished here and there with benches, the whole disposed with much care and taste. The house also is very well arranged. All the rooms look out upon the lake, lying hardly a gunshot from the windows. There are a parlor and a dining-room on the first floor, beside two smaller rooms; and on the same floor two doors lead out into the flower garden. The kitchen is small, and on one side is a pretty ground where we can dine in the open air in summer. The distribution of rooms in the upper story is the same, with a large additional room for the accommodation of your father's catechumens. A jasmine vine drapes the front of the house and climbs to the very roof. . . .

To this quiet pretty parsonage Madame Agassiz became much attached. Her tranquil life is well described in a letter written many years afterward by one of her daughters. "Here mama returned to her spinning-wheel with new ardor. It was a work she much liked, and in which she was very skillful. In

former times at grandpapa's every woman in the house, whether mistress or maid, had her wheel, and the young ladies were accustomed to spin and make up their own trousseaus. Later, mama continued her spinning for her children, and even for her grandchildren. We all preserve as a precious souvenir, table linen of her making. We delighted to see her at her wheel, she was so graceful, and the thread of her thought seemed to follow, so to speak, the fine and delicate thread of her work as it unwound itself under her touch from the distaff."

Agassiz was detained by his publishing arrangements and his work longer than he had expected, and November was already advanced before his preparations for leaving Munich were completed.

TO HIS PARENTS.

MUNICH, *November* 9, 1830.

. . . According to your wish [this refers to a suggestion about a fellow-student in a previous letter] I shall not bring any friend with me. I long to enjoy the pleasure of family life. I shall, however, be accompanied by one person, for whom I should like to make suitable arrangements. He is the

artist who makes all my drawings. If there is no room for him in the house he can be lodged elsewhere; but I wish you could give me the use of a well-lighted room, where I could work and he could draw at my side through the day. Do not be frightened; he is not at my charge; but it would be a great advantage to me if I could have him in the house. As I do not want to lose time in the mechanical part of my work, I would beg papa to engage for me some handy boy, fifteen years old or so, whom I could employ in cleaning skeletons and the like. Finally, you will receive several boxes for me; leave them unopened till I come, without even paying the freight upon them, — the most unsatisfactory of all expenses; — and I do not wish you to have an unpleasant association with my collections.

My affairs are all in order with Cotta, and I have even concluded the arrangement more advantageously than I had dared to hope, — a thousand louis, six hundred payable on the publication of the first number, and four hundred in installments, as the publication goes on. If I had not been in haste to close the matter in order to secure myself against all doubt, I might have done even better. But I

hope I have reconciled you thereby to Natural History. What remains to be done will be the work of less than half a year, during which I wish also to get together the materials for my second work, on the fossils. Of that I have already spoken with my publisher, and he will take it on more favorable conditions than I could have dictated. Do your best to find me subscribers, that we may soon make our typographical arrangements. . . .

His father's answer, full of fun as it is, shows, nevertheless, that the prospect of domesticating not only the naturalist and his collections, but artist and assistant also, was rather startling.

FROM HIS FATHER.

CONCISE, *November* 16, 1830.

. . . You speak of Christmas as the moment of your arrival; let us call it the New Year. You will naturally pass some days at Neuchâtel to be with your brother, to see the Messrs. Coulon, etc.; from there to Cudrefin for a look at your collection; then to Concise, then to Montagny, Orbe, Lausanne, Geneva, etc.: M. le Docteur will be claimed and fêted by all in turn. And during all

these indispensable excursions, for which, to be within bounds, I allow a month at least, it is as clear as daylight that regular work must be set aside, if, indeed, the time be not wholly lost. Now, for Heaven's sake, what will you do, or rather what shall *we* do, with your painter, in this interval employed by you elsewhere. Neither is this all. Though the date of Cecile's marriage is not fixed, it is more than likely to take place in January, so that you will be here for the wedding. If you will recollect the overturning of the paternal mansion when your outfit was preparing for Bienne, Zurich, and other places, you can form an idea of the state of our rooms above and below, large and small, when the work of the trousseau begins. Where, in Heaven's name, will you stow away a painter and an assistant in the midst of half a brigade of dress-makers, seamstresses, lace-makers, and milliners, without counting the accompanying train of friends? Where would you, or where could you, put under shelter your possessions (I dare not undertake to enumerate them), among all the taffetas and brocades, linens, muslin, tulles, laces, etc.? But what am I saying? I doubt if these names are still in existence, for quite other appellations are sound-

ing in my ears, each one of which, to the number of some hundred, signifies at least twenty yards in width, to say nothing of the length. For my part, I have already, notwithstanding the approach of winter, put up a big nail in the garret, on which to hang my bands and surplice. Listen, then, to the conclusion of your father. Give all possible care to your affairs in Munich, put them in perfect order, leave nothing to be done, and leave nothing behind *except the painter*. You can call him in from here, whenever you think you can make use of him.

TO HIS PARENTS.

MUNICH, *November* 26, 1830.

. . . When you receive this I shall be no longer in Munich; by means of a last draft on M. Eichthal I have settled with every one, and I hope to leave the day after to-morrow. I fully recognize the justice of your observations, my dear father, but as you start from a mistaken point of view, they do not coincide altogether with existing circumstances. I intend to stay with you until the approach of summer, not only with the aim of working upon the text of my book, but chiefly in order to take advantage of all the fossil collections

in Switzerland. For that purpose I positively need a draughtsman, who, thanks to my publisher, is not in my pay, and who must accompany me in future wherever I go. Since there is no room at home, please see how he can be lodged in the neighborhood. I have, at the utmost, to glance each day at what he has done. I can even give him work for several weeks in which my presence would be unnecessary. If there is a considerable collection of fossils at Zurich, I shall leave him there till he has finished his work, and then he will rejoin me; all that depends upon circumstances. In any case he must not be a charge to you, still less interfere with our family privacy. That I may spend all my time with you, I shall at present bring with me nothing that is not absolutely necessary. We shall see later where I shall place my museum. As to visits, they are not to be thought of until the spring. I could not bear the idea of interruption before the first number of my "Fishes" is finished.

The artist in question was Mr. Dinkel. His relations with the family became of a truly friendly character. The connection between him and Agassiz, most honorable to both par-

ties, lasted for sixteen years, and was then only interrupted by the departure of Agassiz for America. During this whole period Mr. Dinkel was occupied as his draughtsman, living sometimes in Paris, sometimes in England, sometimes in Switzerland, wherever, in short, there were specimens to be drawn. In a private letter, written long afterward, he says, in speaking of the break in their intercourse caused by Agassiz's removal to America: "For a long time I felt unhappy at that separation. . . . He was a kind, noble-hearted friend; he was very benevolent, and if he had possessed millions of money he would have spent them for his researches in science, and have done good to his fellow-creatures as much as possible."

Some passages from Braun's letters complete the chapter of these years in Munich, so rich in purpose and in experience, the prelude, as it were, to the intellectual life of the two friends who had entered upon them together. These extracts show how seriously, not without a certain sadness, they near the end.

BRAUN TO HIS FATHER.

MUNICH, *November* 7, 1830.

Were I to leave Munich now, I must separate myself from Agassiz and Schimper, which would be neither agreeable nor advantageous for me, nor would it be friendly toward them. We will not shorten the time, already too scantly measured, which we may still spend so quietly, so wholly by ourselves, but rather, as long as it lasts, make the best use of it in a mutual exchange of what we have learned, trying to encourage each other in the right path, and drawing more closely together for our whole life to come. Agassiz is to stay till the end of the month; during this time he will give us lectures in anatomy, and I shall learn a good deal of zoölogy. Beside all this one thing is certain; namely, that we can review our medical work much more quietly and uninterruptedly here than in Carlsruhe. Add to this, the advantage we enjoy here of visiting the hospitals. . . . The time passes delightfully with us of late, for Agassiz has received several baskets of books from Cotta, among others, Schiller's and Goethe's complete works, the Conversations-Lexicon, medical works, and works on natural history. How many books

a man may receive in return for writing only one! They are, of course, deducted from his share of the profits. Yesterday we did nothing but read Goethe the whole day.

A brief account of Agassiz's university life, dictated by himself, may fitly close the record of this period. He was often urged to put together a few reminiscences of his life, but he lived so intensely in the present, every day bringing its full task, that he had little time for retrospect, and this sketch remained a fragment. It includes some facts already told, but is given almost verbatim, because it forms a sort of summary of his intellectual development up to this date.

"I am conscious that at successive periods of my life I have employed very different means and followed very different systems of study. I may, therefore, be allowed to offer the result of my experience as a contribution toward the building up of a sound method for the promotion of the study of nature.

"At first, when a mere boy, twelve years of age, I did what most beginners do. I picked up whatever I could lay my hands on, and tried, by such books and authorities as I had at my command, to find the names of these

objects. My highest ambition, at that time, was to be able to designate the plants and animals of my native country correctly by a Latin name, and to extend gradually a similar knowledge in its application to the productions of other countries. This seemed to me, in those days, the legitimate aim and proper work of a naturalist. I still possess manuscript volumes in which I entered the names of all the animals and plants with which I became acquainted, and I well remember that I then ardently hoped to acquire the same superficial familiarity with the whole creation. I did not then know how much more important it is to the naturalist to understand the structure of a few animals, than to command the whole field of scientific nomenclature. Since I have become a teacher, and have watched the progress of students, I have seen that they all begin in the same way; but how many have grown old in the pursuit, without ever rising to any higher conception of the study of nature, spending their life in the determination of species, and in extending scientific terminology! Long before I went to the university, and before I began to study natural history under the guidance of men who were masters in the science during the early part of

this century, I perceived that while nomenclature and classification, as then understood, formed an important part of the study, being, in fact, its technical language, the study of living beings in their natural element was of infinitely greater value. At that age, namely, about fifteen, I spent most of the time I could spare from classical and mathematical studies in hunting the neighboring woods and meadows for birds, insects, and land and fresh-water shells. My room became a little menagerie, while the stone basin under the fountain in our yard was my reservoir for all the fishes I could catch. Indeed, collecting, fishing, and raising caterpillars, from which I reared fresh, beautiful butterflies, were then my chief pastimes. What I know of the habits of the fresh-water fishes of Central Europe I mostly learned at that time; and I may add, that when afterward I obtained access to a large library and could consult the works of Bloch and Lacépède, the only extensive works on fishes then in existence, I wondered that they contained so little about their habits, natural attitudes, and mode of action with which I was so familiar.

"The first course of lectures on zoölogy I attended was given in Lausanne in 1823. It

consisted chiefly of extracts from Cuvier's 'Règne Animal,' and from Lamarck's 'Animaux sans Vertèbres.' I now became aware, for the first time, that the learned differ in their classifications. With this discovery, an immense field of study opened before me, and I longed for some knowledge of anatomy, that I might see for myself where the truth was. During two years spent in the Medical School of Zurich, I applied myself exclusively to the study of anatomy, physiology, and zoölogy, under the guidance of Professors Schinz and Hirzel. My inability to buy books was, perhaps, not so great a misfortune as it seemed to me; at least, it saved me from too great dependence on written authority. I spent all my time in dissecting animals and in studying human anatomy, not forgetting my favorite amusements of fishing and collecting. I was always surrounded with pets, and had at this time some forty birds flying about my study, with no other home than a large pine-tree in the corner. I still remember my grief when a visitor, entering suddenly, caught one of my little favorites between the floor and the door, and he was killed before I could extricate him. Professor Schinz's private collection of birds was my daily resort, and I then described every

bird it contained, as I could not afford to buy even a text-book of ornithology. I also copied with my own hand, having no means of purchasing the work, two volumes of Lamarck's 'Animaux sans Vertèbres,' and my dear brother copied another half volume for me. I finally learned that the study of the things themselves was far more attractive than the books I so much coveted; and when, at last, large libraries became accessible to me, I usually contented myself with turning over the leaves of the volumes on natural history, looking at the illustrations, and recording the titles of the works, that I might readily consult them for identification of such objects as I should have an opportunity of examining in nature.

"After spending in this way two years in Zurich, I was attracted to Heidelberg by the great reputation of its celebrated teachers, Tiedemann, Leuckart, Bronn, and others. It is true that I was still obliged to give up a part of my time to the study of medicine, but while advancing in my professional course by a steady application to anatomy and physiology, I attended the lectures of Leuckart in zoölogy, and those of Bronn in paleontology. The publication of Goldfuss's great work on the fossils

of Germany was just then beginning, and it opened a new world to me. Familiar as I was with Cuvier's 'Règne Animal,' I had not then seen his 'Researches on Fossil Remains,' and the study of fossils seemed to me only an extension of the field of zoölogy. I had no idea of its direct connection with geology, or of its bearing on the problem of the successive introduction of animals on the earth. I had never thought of the larger and more philosophical view of nature as one great world, but considered the study of animals only as it was taught by descriptive zoölogy in those days. At about this time, however, I made the acquaintance of two young botanists, Braun and Schimper, both of whom have since become distinguished in the annals of science. Botany had in those days received a new impulse from the great conceptions of Goethe. The metamorphosis of plants was the chief study of my friends, and I could not but feel that descriptive zoölogy had not spoken the last word in our science, and that grand generalizations, such as were opening upon botanists, must be preparing for zoölogists also. Intimate contact with German students made me feel that I had neglected my philosophical education; and when, in the

year 1827, the new University of Munich opened, with Schelling as professor of philosophy, Oken, Schubert, and Wagler as professors of zoölogy, Döllinger as professor of anatomy and physiology, Martius and Zuccarini as professors of botany, Fuchs and Kobell as professors of mineralogy, I determined to go there with my two friends and drink new draughts of knowledge. During the years I passed at Munich I devoted myself almost exclusively to the different branches of natural science, neglecting more and more my medical studies, because I began to feel an increasing confidence that I could fight my way in the world as a naturalist, and that I was therefore justified in following my strong bent in that direction. My experience in Munich was very varied. With Döllinger I learned to value accuracy of observation. As I was living in his house, he gave me personal instruction in the use of the microscope, and showed me his own methods of embryological investigation. He had already been the teacher of Karl Ernst von Baer; and though the pupil outran the master, and has become the pride of the scientific world, it is but just to remember that he owed to him his first initiation into the processes of embryological research. Döllin-

ger was a careful, minute, persevering observer, as well as a deep thinker; but he was as indolent with his pen as he was industrious with his brain. He gave his intellectual capital to his pupils without stint or reserve, and nothing delighted him more than to sit down for a quiet talk on scientific matters with a few students, or to take a ramble with them into the fields outside the city, and explain to them as he walked the result of any recent investigation he had made. If he found himself understood by his listeners he was satisfied, and cared for no farther publication of his researches. I could enumerate many works of masters in our science, which had no other foundation at the outset than these inspiriting conversations. No one has borne warmer testimony to the influence Döllinger has had in this indirect way on the progress of our science than the investigator I have already mentioned as his greatest pupil, — von Baer. In the introduction to his work on embryology he gratefully acknowledges his debt to his old teacher.

"Among the most fascinating of our professors was Oken. A master in the art of teaching, he exercised an almost irresistible influence over his students. Constructing the

universe out of his own brain, deducing from *a priori* conceptions all the relations of the three kingdoms into which he divided all living beings, classifying the animals as if by magic, in accordance with an analogy based on the dismembered body of man, it seemed to us who listened that the slow laborious process of accumulating precise detailed knowledge could only be the work of drones, while a generous, commanding spirit might build the world out of its own powerful imagination. The temptation to impose one's own ideas upon nature, to explain her mysteries by brilliant theories rather than by patient study of the facts as we find them, still leads us away. With the school of the physio-philosophers began (at least in our day and generation) that overbearing confidence in the abstract conceptions of the human mind as applied to the study of nature, which still impairs the fairness of our classifications and prevents them from interpreting truly the natural relations binding together all living beings. And yet, the young naturalist of that day who did not share, in some degree, the intellectual stimulus given to scientific pursuits by physio-philosophy would have missed a part of his training. There is a great dis-

tance between the man who, like Oken, attempts to construct the whole system of nature from general premises and the one who, while subordinating his conceptions to the facts, is yet capable of generalizing the facts, of recognizing their most comprehensive relations. No thoughtful naturalist can silence the suggestions, continually arising in the course of his investigations, respecting the origin and deeper connection of all living beings; but he is the truest student of nature who, while seeking the solution of these great problems, admits that the only true scientific system must be one in which the thought, the intellectual structure, rises out of and is based upon facts. The great merit of the physio-philosophers consisted in their suggestiveness. They did much in freeing our age from the low estimation of natural history as a science which prevailed in the last century. They stimulated a spirit of independence among observers; but they also instilled a spirit of daring, which, from its extravagance, has been fatal to the whole school. He is lost, as an observer, who believes that he can, with impunity, affirm that for which he can adduce no evidence. It was a curious intellectual experience to listen day after day to the lec-

tures of Oken, while following at the same time Schelling's courses, where he was shifting the whole ground of his philosophy from its negative foundation as an *a priori* doctrine to a positive basis, as an historical science. He unfolded his views in a succession of exquisite lectures, delivered during four consecutive years.

"Among my fellow-students were many young men who now rank among the highest lights in the various departments of science, and others, of equal promise, whose early death cut short their work in this world. Some of us had already learned at this time to work for ourselves; not merely to attend lectures and study from books. The best spirit of emulation existed among us; we met often to discuss our observations, undertook frequent excursions in the neighborhood, delivered lectures to our fellow-students, and had, not infrequently, the gratification of seeing our university professors among the listeners. These exercises were of the highest value to me as a preparation for speaking, in later years, before larger audiences. My study was usually the lecture-room. It would hold conveniently from fifteen to twenty persons, and both students and professors used to call

our quarters "The Little Academy." In that room I made all the skeletons represented on the plates of Wagler's "Natural System of Reptiles;" there I once received the great anatomist, Meckel, sent to me by Döllinger, to examine my anatomical preparations and especially the many fish-skeletons I had made from fresh-water fishes. By my side were constantly at work two artists; one engaged in drawing various objects of natural history, the other in drawing fossil fishes. I kept always one and sometimes two artists in my pay; it was not easy, with an allowance of $250 a year, but they were even poorer than I, and so we managed to get along together. My microscope I had earned by writing.

"I had hardly finished the publication of the Brazilian Fishes, when I began to study the works of the older naturalists. Professor Döllinger had presented me with a copy of Rondelet, which was my delight for a long time. I was especially struck by the *naïveté* of his narrative and the minuteness of his descriptions as well as by the fidelity of his woodcuts, some of which are to this day the best figures we have of the species they represent. His learning overwhelmed me; I would gladly have read, as he did, everything that had been written before my time; but there were au-

thors who wearied me, and I confess that at that age Linnæus was among the number. I found him dry, pedantic, dogmatic, conceited; while I was charmed with Aristotle, whose zoölogy I have read and re-read ever since at intervals of two or three years. I must, however, do myself the justice to add, that after I knew more of the history of our science I learned also duly to reverence Linnæus. But a student, already familiar with the works of Cuvier, and but indifferently acquainted with the earlier progress of zoölogy, could hardly appreciate the merit of the great reformer of natural history. His defects were easily perceived, and it required more familiarity than mine then was with the gradual growth of the science, from Aristotle onward, to understand how great and beneficial an influence Linnæus had exerted upon modern natural history.

"I cannot review my Munich life without deep gratitude. The city teemed with resources for the student in arts, letters, philosophy, and science. It was distinguished at that time for activity in public as well as in academic life. The king seemed liberal; he was the friend of poets and artists, and aimed at concentrating all the glories of Germany in his new university. I thus enjoyed for a

few years the example of the most brilliant intellects, and that stimulus which is given by competition between men equally eminent in different spheres of human knowledge. Under such circumstances a man either subsides into the position of a follower in the ranks that gather around a master, or he aspires to be a master himself.

"The time had come when even the small allowance I received from borrowed capital must cease. I was now twenty-four years of age. I was Doctor of Philosophy and Medicine, and author of a quarto volume on the fishes of Brazil. I had traveled on foot all over Southern Germany, visited Vienna, and explored extensive tracts of the Alps. I knew every animal, living and fossil, in the Museums of Munich, Stuttgart, Tübingen, Erlangen, Wurzburg, Carlsruhe, and Frankfort; but my prospects were as dark as ever, and I saw no hope of making my way in the world, except by the practical pursuit of my profession as physician. So, at the close of 1830, I left the university and went home, with the intention of applying myself to the practice of medicine, confident that my theoretical information and my training in the art of observing would carry me through the new ordeal I was about to meet."

CHAPTER V.

1830 - 1832 : ÆT. 23 - 25.

Year at Home. — Leaves Home for Paris. — Delays on the Road. — Cholera. — Arrival in Paris. — First Visit to Cuvier. — Cuvier's Kindness. — His Death. — Poverty in Paris. — Home Letters concerning Embarrassments and about his Work. — Singular Dream.

On the 4th of December, 1830, Agassiz left Munich, in company with Mr. Dinkel, and after a short stay at St. Gallen and Zurich, spent in looking up fossil fishes and making drawings of them, they reached Concise on the 30th of the same month. Anxiously as his return was awaited at home, we have seen that his father was not without apprehension lest the presence of the naturalist, with artist, specimens, and apparatus, should be an inconvenience in the quiet parsonage. But every obstacle yielded to the joy of reunion, and Agassiz was soon established with his "painter," his fossils, and all his scientific outfit, under the paternal roof.

Thus quietly engaged in his ichthyological studies, carrying on his work on the fossil

fishes, together with that on the fresh-water fishes of Central Europe, he passed nearly a year at home. He was not without patients also in the village and its environs, but had, as yet, no prospect of permanent professional employment. In the mean time it seemed daily more and more necessary that he should carry his work to Paris, to the great centre of scientific life, where he could have the widest field for comparison and research. There, also, he could continue and complete to the best advantage his medical studies. His poverty was the greatest hindrance to any such move. He was not, however, without some slight independent means, especially since his publishing arrangements provided in part for the carrying on of his work. His generous uncle added something to this, and an old friend of his father's, M. Christinat, a Swiss clergyman with whom he had been from boyhood a great favorite, urged upon him his own contribution toward a work in which he felt the liveliest interest. Still the prospect with which he left for Paris in September, 1831, was dark enough, financially speaking, though full of hope in another sense. On the road he made several halts for purposes of study, combining, as usual, professional with scien-

tific objects, hospitals with museums. He was, perhaps, a little inclined to believe that the most favorable conditions for his medical studies were to be found in conjunction with the best collections. He had, however, a special medical purpose, being earnest to learn everything regarding the treatment and the limitation of cholera, then for the first time making its appearance in Western Europe with frightful virulence. Believing himself likely to continue the practice of medicine for some years at least, he thought his observations upon this scourge would be of great importance to him. His letters of this date to his father are full of the subject, and of his own efforts to ascertain the best means of prevention and defense. The following answer to an appeal from his mother shows, however, that his delays caused anxiety at home, lest the small means he could devote to his studies in Paris should be consumed on the road.

TO HIS MOTHER.

CARLSRUHE, *November*, 1831.

. . . I returned day before yesterday from my trip in Würtemberg, and though I already knew what precautions had been taken everywhere in anticipation of cholera, I do

not think my journey was a useless one, and am convinced that my observations will not be without interest, — chiefly for myself, of course, but of utility to others also I hope. Your letter being so urgent, I will not, however, delay my departure an instant. Between to-day and to-morrow I shall put in order the specimens lent me by the Museum, and then start at once. . . . In proportion to my previous anxiety is my pleasure in the prospect of going to Paris, now that I am better fitted to present myself there as I could wish. I have collected for my fossil fishes all the materials I still desired to obtain from the museums of Carlsruhe, Heidelberg, and Strasbourg, and have extended my knowledge of geology sufficiently to join, without embarrassment at least, in conversation upon the more recent researches in that department. Moreover, Braun has been kind enough to give me a superb collection, selected by himself, to serve as basis and guide in my researches. I leave it at Carlsruhe, since I no longer need it. . . . I have also been able to avail myself of the Museum of Carlsruhe, and of the mineralogical collection of Braun's father. Beside the drawings made by Dinkel, I have added to my work one hundred and seventy-one pages

of manuscript in French (I have just counted them), written between my excursions and in the midst of other occupations. . . . I could not have foreseen so rich a harvest.

Thus prepared, he arrived in Paris with his artist on the 16th of December, 1831. On the 18th he writes to his father. . . . "Dinkel and I had a very pleasant journey, though the day after our arrival I was so fatigued that I could hardly move hand or foot, — that was yesterday. Nevertheless, I passed the evening very agreeably at the house of M. Cuvier, who sent to invite me, having heard of my arrival. To my surprise, I found myself not quite a stranger, — rather, as it were, among old acquaintances. I have already given you my address, Rue Copeau (Hôtel du Jardin du Roi, No. 4). As it happens, M. Perrotet, a traveling naturalist, lives here also, and has at once put me on the right track about whatever I most need to know. There are in the house other well-known persons besides. I am accommodated very cheaply, and am at the same time within easy reach of many things, the neighborhood of which I can turn to good account. The medical school, for instance, is within ten minutes' walk; the Jardin des

Plantes not two hundred steps away; while the Hospital (de la Pitié), where Messieurs Andral and Lisfranc teach, is opposite, and nearer still. To-day or to-morrow I shall deliver my letters, and then set to work in good earnest."

Pleased as he was from the beginning with all that concerned his scientific life in Paris, the next letter shows that the young Swiss did not at once find himself at home in the great French capital.

TO HIS SISTER OLYMPE.

PARIS, *January* 15, 1832.

. . . My expectations in coming here have been more than fulfilled. In scientific matters I have found all that I knew must exist in Paris (indeed, my anticipations were rather below than above the mark), and beside that I have been met everywhere with courtesy, and have received attentions of all sorts. M. Cuvier and M. Humboldt especially treat me on all occasions as an equal, and facilitate for me the use of the scientific collections so that I can work here as if I were at home. And yet it is not the same thing; this extreme, but formal politeness chills you instead of putting you at your ease; it lacks cordiality,

and, to tell the truth, I would gladly go away were I not held fast by the wealth of material of which I can avail myself for instruction. In the morning I follow the clinical courses at the Pitié. . . . At ten o'clock, or perhaps at eleven, I breakfast, and then go to the Museum of Natural History, where I stay till dark. Between five and six I dine, and after that turn to such medical studies as do not require daylight. So pass my days, one like another, with great regularity. I have made it a rule not to go out after dinner, — I should lose too much time. . . . On Saturday only I spend the evening at M. Cuvier's. . . .

The homesickness which is easily to be read between the lines of this letter, due, perhaps, to the writer's want of familiarity with society in its conventional aspect, yielded to the influence of an intellectual life, which became daily more engrossing. Cuvier's kind reception was but an earnest of the affectionate interest he seems from the first to have felt in him. After a few days he gave Agassiz and his artist a corner in one of his own laboratories, and often came to encourage them by a glance at their work as it went on.

This relation continued until Cuvier's death, and Agassiz enjoyed for several months the scientific sympathy and personal friendship of the great master whom he had honored from childhood, and whose name was ever on his lips till his own work in this world was closed. The following letter, written two months later, to his uncle in Lausanne tells the story in detail.

TO DR. MAYOR.

PARIS, *February* 16, 1832.

. . . I have also a piece of good news to communicate, which will, I hope, lead to very favorable results for me. I think I told you when I left for Paris that my chief anxiety was lest I might not be allowed to examine, and still less to describe, the fossil fishes and their skeletons in the Museum. Knowing that Cuvier intended to write a work on this subject, I supposed that he would reserve these specimens for himself. I half thought he might, on seeing my work so far advanced, propose to me to finish it jointly with him, — but even this I hardly dared to hope. It was on this account, with the view of increasing my materials and having thereby a better chance of success with M. Cuvier, that I

desired so earnestly to stop at Strasbourg and Carlsruhe, where I knew specimens were to be seen which would have a direct bearing on my aim. The result has far surpassed my expectation. I hastened to show my material to M. Cuvier the very day after my arrival. He received me with great politeness, though with a certain reserve, and immediately gave me permission to see everything in the galleries of the Museum. But as I knew that he had put together in private collections all that could be of use to himself in writing his book, and as he had never said a word to me of his plan of publication, I remained in a painful state of doubt, since the completion of his work would have destroyed all chance for the sale of mine. Last Saturday I was passing the evening there, and we were talking of science, when he desired his secretary to bring him a certain portfolio of drawings. He showed me the contents; they were drawings of fossil fishes and notes which he had taken in the British Museum and elsewhere. After looking it through with me, he said he had seen with satisfaction the manner in which I had treated this subject; that I had indeed anticipated him, since he had intended at some future time to do the same thing;

but that as I had given it so much attention, and had done my work so well, he had decided to renounce his project, and to place at my disposition all the materials he had collected and all the preliminary notes he had taken.

You can imagine what new ardor this has given me for my work, the more so because M. Cuvier, M. Humboldt, and several other persons of mark who are interested in it have promised to speak in my behalf to a publisher (to Levrault, who seems disposed to undertake the publication should peace be continued), and to recommend me strongly. To accomplish my end without neglecting other occupations, I work regularly at least fifteen hours a day, sometimes even an hour or two more; but I hope to reach my goal in good time.

This trust from Cuvier proved to be a legacy. Less than three months after the date of this letter Agassiz went, as often happened, to work one morning with him in his study. It was Sunday, and he was employed upon something which Cuvier had asked him to do, saying, "You are young; you have time enough for it, and I have none to spare." They worked together till eleven o'clock, when Cuvier invited Agassiz to join him at breakfast.

After a little time spent over the breakfast table in talk with the ladies of the family, while Cuvier opened his letters, papers, etc., they returned to the working room, and were busily engaged in their separate occupations when Agassiz was surprised to hear the clock strike five, the hour for his dinner. He expressed his regret that he had not quite finished his work, but said that as he belonged to a student's table his dinner would not wait for him, and he would return soon to complete his task. Cuvier answered that he was quite right not to neglect his regular hours for meals, and commended his devotion to study, but added, "Be careful, and remember that *work kills*." They were the last words he heard from his beloved teacher. The next day, as Cuvier was going up to the tribune in the Chamber of Deputies, he fell, was taken up paralyzed, and carried home. Agassiz never saw him again.[1]

In order to keep intact these few data respecting his personal relations with Cuvier, as told in later years by Agassiz himself, the

[1] This warning of Cuvier, "Work kills," strangely recalls Johannes Müller's "Blood clings to work;" the one seems the echo of the other. See *Memoir of Johannes Müller*, by Rudolf Virchow, p. 38.

course of the narrative has been anticipated by a month or two. Let us now return to the natural order. The letter to his uncle of course gave great pleasure at home. Just after reading it his father writes (February, 1832), "Now that you are intrusted with the portfolio of M. Cuvier, I suppose your plan is considerably enlarged, and that your work will be of double volume; tell me, then, as much about it as you think I can understand, which will not be a great deal after all." His mother's letter on the same occasion is full of tender sympathy and gratitude.

Meanwhile one daily anxiety embittered his scientific happiness. The small means at his command could hardly be made, even with the strictest economy, to cover the necessary expenses of himself and his artist, in which were included books, drawing materials, fees, etc. He was in constant terror lest he should be obliged to leave Paris, to give up his investigations on the fossil fishes, and to stop work on the costly plates he had begun. The truth about his affairs, which he would gladly have concealed from those at home as long as possible, was drawn from him by an accidental occurrence. His brother had written to him for a certain book, and, failing to receive

it, inquired with some surprise why his commission was neglected. Agassiz's next letter, about a month later than the one to his uncle, gives the explanation.

TO HIS BROTHER.

PARIS, *March*, 1832.

. . . Here is the book for which you asked me, — price, 18 francs. I shall be very sorry if it comes too late, but I could not help it. . . . In the first place I had not money enough to pay for it without being left actually penniless. You can imagine that after the fuel bill for the winter is paid, little remains for other expenses out of my 200 francs a month, five louis of which are always due to my companion. Far from having anything in advance, my month's supply is thus taken up at once. . . . Beside this cause of delay, you can have no idea what it is to hunt for anything in Paris when you are a stranger there. As I go out only in two or three directions leading to my work, and might not otherwise leave my own street for a month at a time, I naturally find myself astray when I am off this beaten track. . . . You have asked me several times how I have been received by those to whom I had introductions. Frankly, after

having delivered a few of my letters, I have never been again, because I cannot, in my position, spare time for visits. . . . Another excellent reason for staying away now is that I have no presentable coat. At M. Cuvier's only am I sufficiently at ease to go in a frock coat. . . . Saturday, a week ago, M. de Férussac offered me the editorship of the zoölogical section of the "Bulletin;" it would be worth to me an additional thousand francs, but would require two or three hours' work daily. Write me soon what you think about it. In the midst of all the encouragements which sustain me and renew my ardor, I am depressed by the reverse side of my position.

This letter drew forth the following one.

FROM HIS MOTHER.

CONCISE, *March*, 1832.

. . . Much as your letter to your uncle delighted us, that to your brother has saddened us. It seems, my dear child, that you are painfully straitened in means. I understand it by personal experience, and in your case I have foreseen it; it is the cloud which has always darkened your prospects to me. I want to talk to you, my dear Louis, of your

future, which has often made me anxious. You know your mother's heart too well to misunderstand her thought, even should its expression be unacceptable to you. With much knowledge, acquired by assiduous industry, you are still at twenty-five years of age living on brilliant hopes, in relation, it is true, with great people, and known as having distinguished talent. Now, all this would seem to me delightful if you had an income of fifty thousand francs; but, in your position, you must absolutely have an occupation which will enable you to live, and free you from the insupportable weight of dependence on others. From this day forward, my dear child, you must look to this end alone if you would find it possible to pursue honorably the career you have chosen. Otherwise constant embarrassments will so limit your genius, that you will fall below your own capacity. If you follow our advice you will perhaps reach the result of your work in the natural sciences a little later, but all the more surely. Let us see how you can combine the work to which you have already consecrated so much time, with the possibility of self-support. It appears from your letter to your brother that you see no one in Paris; the reason seems to me a sad one, but it

is unanswerable, and since you cannot change it, you must change your place of abode and return to your own country. You have already seen in Paris all those persons whom you thought it essential to see; unless you are strangely mistaken in their good-will, you will be no less sure of it in Switzerland than in Paris, and since you cannot take part in their society, your relations with them will be the same at the distance of a hundred leagues as they are now. You must therefore leave Paris for Geneva, Lausanne, or Neuchâtel, or any city where you can support yourself by teaching. . . . This seems to me the most advantageous course for you. If before fixing yourself permanently you like to take your place at the parsonage again, you will always find us ready to facilitate, as far as we can, any arrangements for your convenience. Here you can live in perfect tranquillity and without expense.

There are two other subjects which I want to discuss with you, though perhaps I shall not make myself so easily understood. You have seen the handsome public building in process of construction at Neuchâtel. It will be finished this year, and I am told that the Museum will be placed there. I believe the

collections are very incomplete, and the city of Neuchâtel is rich enough to expend something in filling the blanks. It has occurred to me, my dear, that this would be an excellent opportunity for disposing of your alcoholic specimens. They form, at present, a capital yielding no interest, requiring care, and to be enjoyed only at the cost of endless outlay in glass jars, alcohol, and transportation, to say nothing of the rent of a room in which to keep them. All this, beside attracting many visitors, is too heavy a burden for you, from which you may free yourself by taking advantage of this rare chance. To this end you must have an immediate understanding with M. Coulon, lest he should make a choice elsewhere. Your brother, being on the spot, might negotiate for you. . . . Finally, my last topic is Mr. Dinkel. You are very fortunate to have found in your artist such a thoroughly nice fellow; nevertheless, in view of the expense, you must make it possible to do without him. I see you look at me aghast; but where a sacrifice is to be made we must not do it by halves; we must pull up the tree by the roots. It is a great evil to be spending more than one earns. . . .

TO HIS MOTHER.

PARIS, *March* 25, 1832.

. . . It is true, dear mother, that I am greatly straitened; that I have much less money to spend than I could wish, or even than I need; on the other hand, this makes me work the harder, and keeps me away from distractions which might otherwise tempt me. . . . With reference to my work, however, things are not quite as you suppose, as regards either my stay here or my relations with M. Cuvier. Certainly, I hope that I should lose neither his good-will nor his protection on leaving here; on the contrary, I am sure that he would be the first to advise me to accept any professorship, or any place which might be advantageous for me, however removed from my present occupations, and that his counsels would follow me there. But what cannot follow me, and what I owe quite as much to him, is the privilege of examining all the collections. These I can have nowhere but in Paris, since even if he would consent to it I could not carry away with me a hundred quintals of fossil fish, which, for the sake of comparison, I must have before my eyes, nor thousands of fish-skeletons, which would alone

fill some fifty great cases. It is this which compels me to stay here till I have finished my work. I should add that M. Elie de Beaumont has also been kind enough to place at my disposition the fossil fishes from the collection at the Mining School, and that M. Brongniart has made me the same offer regarding his collection, which is one of the finest among those owned by individuals in Paris. . . .

As to my collections, I had already thought of asking either the Vaudois government or the city of Neuchâtel to receive them into the Museum, merely on condition that they should provide for the expenses of exhibition and preservation, making use of them, meanwhile, for the instruction of the public. I should be sorry to lose all right to them, because I hope they may have another final destination. I do not despair of seeing the different parts of Switzerland united at some future day by a closer tie, and in case of such a union a truly Helvetic university would become a necessity; then, my aim would be to make my collection the basis of that which they would be obliged to found for their courses of lectures. It is really a shame that Switzerland, richer and more extensive than

many a small kingdom, should have no university, when some states of not half its size have even two; for instance, the grand duchy of Baden, one of whose universities, that of Heidelberg, ranks among the first in all Germany. If ever I attain a position allowing me so to do, I shall make every effort in my power to procure for my country the greatest of benefits: namely, that of an intellectual unity, which can arise only from a high degree of civilization, and from the radiation of knowledge from one central point.

I, too, have considered the question about Dinkel, and if, when I have finished my work here, my position is not changed, and I have no definite prospect, such as would justify me in keeping him with me, — well! then we must part! I have long been preparing myself for this, by employing him only upon what is indispensable to the publication of my first numbers, hoping that these may procure me the means of paying for such illustrations as I shall further need. As my justification for having engaged him in the first instance, and continued this expense till now, I can truly say that it is in a great degree through his drawings that M. Cuvier has been able to judge of my work, and so has been led to

make a surrender of all his materials in my favor. I foresaw clearly that this was my only chance of competing with him, and it was not without reason that I insisted so strongly on having Dinkel with me in passing through Strasbourg and subsequently at Carlsruhe. Had I not done so, M. Cuvier might still be in advance of me. Now my mind is at rest on this score; I have already written you all about his kindness in offering me the work. Could I only be equally fortunate in its publication!

M. Cuvier urges me strongly to present my book to the Academy, in order to obtain a report upon its contents. I must first finish it, however, and the task is not a light one. For this reason, above all, I regret my want of means; but for that I could have the drawings made at once, and the Academy report, considered as a recommendation, would certainly help on the publication greatly. But in this respect I have long been straitened; Auguste knows that I had at Munich an artist who was to complete what I had left there for execution, and that I stopped his work on leaving Concise. If the stagnation of the book-trade continues I shall, perhaps, be forced to give up Dinkel also; for if I cannot be-

gin the publication, which will, I hope, bring me some return, I must cease to accumulate material in advance. Should business revive soon, however, I may yet have the pleasure of seeing all completed before I leave Paris.

I think I forgot to mention the arrival of Braun six weeks after me. I had a double pleasure in his coming, for he brought with him his younger brother, a charming fellow, and a distinguished pupil of the polytechnic school of Carlsruhe. He means to be a mining engineer, and comes to study such collections at Paris as are connected with this branch. You cannot imagine what happiness and comfort I have in my relations with Alexander; he is so good, so cultivated and high-minded, that his friendship is a real blessing to me. We both feel very much our separation from the elder Schimper, who, spite of his great desire to join us at Carlsruhe and accompany us to Paris, was not able to leave Munich. . . .

P. S. My love to Auguste. To-day (Sunday) I went again to see M. Humboldt about Auguste's[1] plan, but did not find him.

Then follow several pages, addressed to his

[1] Concerning a business undertaking in Mexico.

father, in answer to the request contained in one of his last letters that Louis would tell him as much as he thinks he can understand of his work. There is something touching in this little lesson given by the son to the father, as showing with what delight Louis responded to the least touch of parental affection respecting his favorite studies, so long looked upon at home with a certain doubt and suspicion. The whole letter is not given here, as it is simply an elementary treatise on geology; but the close is not without interest as relating to the special investigations on which he was now employed.

"The aim of our researches upon fossil animals is to ascertain what beings have lived at each one of these (geological) epochs of creation, and to trace their characters and their relations with those now living; in one word, to make them live again in our thought. It is especially the fishes that I try to restore for the eyes of the curious, by showing them which ones have lived in each epoch, what were their forms, and, if possible, by drawing some conclusions as to their probable modes of life. You will better understand the difficulty of my work when I tell you that in many species I have only a single tooth, a

scale, a spine, as my guide in the reconstruction of all these characters, although sometimes we are fortunate enough to find species with the fins and the skeletons complete. . . .

"I ask pardon if I have tired you with my long talk, but you know how pleasant it is to ramble on about what interests us, and the pleasure of being questioned by you upon subjects of this kind has been such a rare one for me, that I have wished to present the matter in its full light, that you may understand the zeal and the enthusiasm which such researches can excite."

To this period belongs a curious dream mentioned by Agassiz in his work on the fossil fishes.[1] It is interesting both as a psychological fact and as showing how, sleeping and waking, his work was ever present with him. He had been for two weeks striving to decipher the somewhat obscure impression of a fossil fish on the stone slab in which it was preserved. Weary and perplexed he put his work aside at last, and tried to dismiss it from his mind. Shortly after, he waked one night persuaded that while asleep he had seen his fish with all the missing features perfectly restored.

[1] *Recherches sur les Poissons Fossiles.* Cyclopoma spinosum Agassiz. Vol. iv. tab. 1, pp. 20, 21.

But when he tried to hold and make fast the image, it escaped him. Nevertheless, he went early to the Jardin des Plantes, thinking that on looking anew at the impression he should see something which would put him on the track of his vision. In vain, — the blurred record was as blank as ever. The next night he saw the fish again, but with no more satisfactory result. When he awoke it disappeared from his memory as before. Hoping that the same experience might be repeated, on the third night he placed a pencil and paper beside his bed before going to sleep. Accordingly toward morning the fish reappeared in his dream, confusedly at first, but at last with such distinctness that he had no longer any doubt as to its zoölogical characters. Still half dreaming, in perfect darkness, he traced these characters on the sheet of paper at the bedside. In the morning he was surprised to see in his nocturnal sketch features which he thought it impossible the fossil itself should reveal. He hastened to the Jardin des Plantes, and, with his drawing as a guide, succeeded in chiseling away the surface of the stone under which portions of the fish proved to be hidden. When wholly exposed it corresponded with his dream and his drawing, and he suc-

ceeded in classifying it with ease. He often spoke of this as a good illustration of the well-known fact, that when the body is at rest the tired brain will do the work it refused before.

CHAPTER VI.

1832 : ÆT. 25.

Unexpected Relief from Difficulties. — Correspondence with Humboldt. — Excursion to the Coast of Normandy. — First Sight of the Sea. — Correspondence concerning Professorship at Neuchâtel. — Birthday Fête. — Invitation to Chair of Natural History at Neuchâtel. — Acceptance. — Letter to Humboldt.

AGASSIZ was not called upon to make the sacrifice of giving up his artist and leaving Paris, although he was, or at least thought himself, prepared for it. The darkest hour is before the dawn, and the letter next given announces an unexpected relief from pressing distress and anxiety.

TO HIS FATHER AND MOTHER.

PARIS, *March*, 1832.

. . . I am still so agitated and so surprised at what has just happened that I scarcely believe what my eyes tell me.

I mentioned in a postscript to my last letter that I had called yesterday on M. de Hum-

boldt, whom I had not seen for a long time, in order to speak to him concerning Auguste's affair, but that I did not find him. In former visits I had spoken to him about my position, and told him that I did not well know what course to take with my publisher. He offered to write to him, and did so more than two months ago. Thus far, neither he nor I have had any answer. This morning, just as I was going out, a letter came from M. de Humboldt, who writes me that he is very uneasy at receiving no reply from Cotta, that he fears lest the uncertainty and anxiety of mind resulting from this may be injurious to my work, and begs me to accept the inclosed credit of a thousand francs. . . . Oh! if my mother would forget for one moment that this is the celebrated M. de Humboldt, and find courage to write him only a few lines, how grateful I should be to her. I think it would come better from her than from papa, who would do it more correctly, no doubt, but perhaps not quite as I should like. Humboldt is so good, so indulgent, that you should not hesitate, dear mother, to write him a few lines. He lives Rue du Colombier, No. 22; address, quite simply, M. de Humboldt. . . .

In the agitation of the moment the letter was not even signed.

The following note from Humboldt to Mme. Agassiz, kept by her as a precious possession, shows that in answer to her son's appeal his mother took her courage, as the French saying is, "with both hands," and wrote as she was desired.

FROM HUMBOLDT TO MME. AGASSIZ.

PARIS, *April* 11, 1832.

I should scold your son, Madame, for having spoken to you of the slight mark of interest I have been able to show him; and yet, how can I complain of a letter so touching, so noble in sentiment, as the one I have just received from your hand. Accept my warmest thanks for it. How happy you are to have a son so distinguished by his talents, by the variety and solidity of his acquirements, and, withal, as modest as if he knew nothing, — in these days, too, when youth is generally characterized by a cold and scornful *amour-propre*. One might well despair of the world if a person like your son, with information so substantial and manners so sweet and prepossessing, should fail to make his way. I approve highly the Neuchâtel plan, and hope,

in case of need, to contribute to its success. One must aim at a settled position in life.

Pray excuse, Madame, the brevity of these lines, and accept the assurance of my respectful regard. HUMBOLDT.

The letter which lifted such a load of care from Louis and his parents was as follows: —

HUMBOLDT TO LOUIS AGASSIZ.

PARIS, *March* 27, 1832.

I am very uneasy, my dearest M. Agassiz, at being still without any letter from Cotta. Has he been prevented from writing by business, or illness perhaps? You know how tardy he always is about writing. Yesterday (Monday) I wrote him earnestly again concerning your affair (an undertaking of such moment for science), and urged upon him the issuing of the fossil and fresh-water fishes in alternate numbers. In the mean time, I fear that the protracted delay may weigh heavily on you and your friends. A man so laborious, so gifted, and so deserving of affection as you are should not be left in a position where lack of serenity disturbs his power of work. You will then surely pardon my friendly goodwill toward you, my dear M. Agassiz, if I en-

treat you to make use of the accompanying small credit. You would do more for me I am sure. Consider it an advance which need not be paid for years, and which I will gladly increase when I go away or even earlier. It would pain me deeply should the urgency of my request made in the closest confidence, — in short, a transaction as between two friends of unequal age, — be disagreeable to you. I should wish to be pleasantly remembered by a young man of your character.

Yours, with the most affectionate respect,

ALEXANDER HUMBOLDT.

With this letter was found the following note of acknowledgment, scrawled in almost illegible pencil marks. Whether sent exactly as it stands or not, it is evidently the first outburst of Agassiz's gratitude.

My benefactor and friend, — it is too much; I cannot find words to tell you how deeply your letter of to-day has moved me. I have just been at your house that I might thank you in person with all my heart; but now I must wait to do so until I have the good fortune to meet you. At what a moment does your help come to me! I inclose a letter from

my dear mother that you may understand my whole position. My parents will now readily consent that I should devote myself entirely to science, and I am freed from the distressing thought that I may be acting contrary to their wishes and their will. But they have not the means to help me, and had proposed that I should return to Switzerland and give lessons either in Geneva or Lausanne. I had already resolved to follow this suggestion in the course of next summer, and had also decided to part with Mr. Dinkel, my faithful companion, as soon as he should have finished the most indispensable drawings of the fossils on which he is now engaged here. I meant to tell you of this on Sunday, and now to-day comes your letter. Imagine what must have been my feeling, after having resolved on renouncing what till now had seemed to me noblest and most desirable in life, to find myself unexpectedly rescued by a kind, helpful hand, and to have again the hope of devoting my whole powers to science, — you can judge of the state into which your letter has thrown me. . . .

Soon after this event Agassiz made a short excursion with Braun and Dinkel to the coast of Normandy; worth noting, because he now

saw the sea for the first time. He wrote home: "For five days we skirted the coast from Havre to Dieppe; at last I have looked upon the sea and its riches. From this excursion of a few days, which I had almost despaired of making, I bring back new ideas, more comprehensive views, and a more accurate knowledge of the great phenomena presented by the ocean in its vast expanse."

Meanwhile the hope he had always entertained of finding a professorship of natural history in his own country was ripening into a definite project. His first letter on this subject to M. Louis Coulon, himself a well-known naturalist, and afterward one of his warmest friends in Neuchâtel, must have been written just before he received from Humboldt the note of the same date, which extricated him from his pecuniary embarrassment.

AGASSIZ TO LOUIS COULON.

PARIS, *March* 27, 1832.

. . . When I had the pleasure of seeing you last summer I several times expressed my strong desire to establish myself near you, and my intention of taking some steps toward obtaining the professorship of natural history to be founded in your Lyceum. The matter

must be more advanced now than it was last year, and you would oblige me greatly by giving me some information concerning it. I have spoken of my project to M. de Humboldt, whom I often see, and who kindly interests himself about my prospects and helps me with his advice. He thinks that under the circumstances, and especially in my position, measures should be taken in advance. There is another point of great importance for me about which I wished also to speak to you. Though you have seen but a small part of it, you nevertheless know that in my different journeys, partly through my relations with other naturalists, partly by exchange, I have made a very fair collection of natural history, especially rich in just those classes which are less fully represented in your museum. My collection might, therefore, fill the gaps in that of the city of Neuchâtel, and make the latter more than adequate for the illustration of a full course of natural history. Should an increase of your zoölogical collection make part of your plans for the Lyceum, I venture to believe that mine would fully answer your purpose. In that case I would offer it to you, since the expense of arranging it, the rent of a room in which to keep it, and, in short, its

support in general, is beyond my means. I must find some way of relieving myself from this burden, although it will be hard to part with these companions of my study, upon which I have based almost all my investigations. I have spoken of this also to M. de Humboldt, who is good enough to show an interest in the matter, and will even take all necessary steps with the government to facilitate this purchase. You would render me the greatest service by giving me your directions about all this, and especially by telling me: 1. On whom the nomination to the professorship depends? 2. With whom the purchase of the collection would rest? 3. What you think I should do with reference to both? Of course you will easily understand that I cannot give up my collections except under the condition that I should be allowed the free use of them. . . .

The answer was not only courteous, but kind, although some time elapsed before the final arrangements were made. Meanwhile the following letter shows us the doubts and temptations which for a moment embarrassed Agassiz in his decision. The death of Cuvier had intervened.

AGASSIZ TO HUMBOLDT.

PARIS, *May*, 1832.

. . . I would not write you until I had definite news from Neuchâtel. Two days ago I received a very delightful letter from M. Coulon, which I hasten to share with you. I will not copy the whole, but extract the essential part. He tells me that he has proposed to the Board of Education the establishment of a professorship of natural history, to be offered to me. The proposition met with a cordial hearing. The need of such a professorship was unanimously recognized, but the President explained that neither would the condition of the treasury allow its establishment in the present year, nor could the proposition be brought before the Council of State until the opening of the new Lyceum.

Monsieur Coulon was commissioned to thank me, and to request me in the name of the board to keep the place in mind; should I prefer it, however, he doubts not that whatever the city could not do might be made good by subscription before next autumn, in which case I could enter upon office at once. He requests a prompt answer in order that he may make all needful preparations. Only too

gladly would I have consulted you about various propositions made to me here in the last few days, and have submitted my course to your approval, had it not been that here, as in Neuchâtel, a prompt answer was urged. Although guided rather by instinct than by anything else, I think, nevertheless, that I have chosen rightly. In such moments, when one cannot see far enough in advance to form an accurate judgment upon deliberation, feeling is, after all, the best adviser; that inner impulse, which is a safe guide if other considerations do not confuse the judgment. This says to me, "Go to Neuchâtel; do not stay in Paris." But I speak in riddles; I must explain myself more clearly. Last Monday Levrault sent for me in order to propose that Valenciennes and I should jointly undertake the publication of the Cuvierian fishes. . . . I was to give a positive answer this week. I have carefully considered it, and have decided that an unconditional engagement would lead me away from my nearest aim, and from what I look upon as the task of my life. The already published volumes of the System of Ichthyology lie too far from the road on which I intend to pursue my researches. Finally, it seems to me that in a quiet retired place

like Neuchâtel, whatever may be growing up within me will have a more independent and individual development than in this restless Paris, where obstacles or difficulties may not perhaps divert me from a given purpose, but may disturb or delay its accomplishment. I will therefore so shape my answer to Levrault as to undertake only single portions of the work, the choice of these, on account of my interest in the fossil and the fresh-water fishes, being allowed me, with the understanding, also, that I should be permitted to have these collections in Switzerland and work them up there. From Paris, also, it would not be so easy to transfer myself to Germany, whereas I could consider Neuchâtel as a provisional position from which I might be called to a German university. . . .

In the mean time, while waiting hopefully the result of his negotiations with Neuchâtel, Agassiz had organized with his friends, the two Brauns, a bachelor life very like the one he and Alexander had led with their classmates in Munich. The little hotel where they lodged had filled up with young German doctors, who had come to visit the hospitals in Paris and study the cholera. Some of these young men

had been their fellow-students at the university, and at their request Agassiz and Braun resumed the practice of giving private lectures on zoölogy and botany, the whole being conducted in the most informal manner, admitting absolute freedom of discussion, as among intimate companions of the same age. Such an interchange naturally led to very genial relations between the amateur professors and their class, and on the eve of Agassiz's birthday (28th of May) his usual audience prepared for him a very pleasant surprise. Returning from a walk after dusk he found Braun in his room. Continuing his stroll within four walls, he and his friend paced the floor together in earnest talk, when, at a signal, Braun suddenly drew him to the window, threw it open, and on the pavement below stood their companions, singing a part song, composed in honor of Agassiz. Deeply moved, he withdrew from the window in time to receive them as they trooped up the stairway to offer their good wishes. They presently led the way to another room which they had dressed with flowers, Agassiz's name, among other decorations, being braided in roses beneath two federal flags crossed on the wall. Here supper was laid, and the rest of the evening passed gayly with songs and

toasts, not only for the hero of the feast and for friends far and near, but for the progress of science, the liberty of the people, and the independence of nations. There could be no meeting of ardent young Germans and Swiss in those days without some mingling of patriotic aspirations with the sentiment of the hour.

The friendly correspondence between Agassiz and M. Coulon regarding the professorship at Neuchâtel was now rapidly bringing the matter to a happy conclusion.

AGASSIZ TO LOUIS COULON.

PARIS, *June* 4, 1832.

I have received your kind letter with great pleasure and hasten to reply. What you write gives me the more satisfaction because it opens to me in the near future the hope of establishing myself in your neighborhood and devoting to my country the fruits of my labor. It is true, as you suppose, that the death of M. Cuvier has sensibly changed my position; indeed, I have already been asked to continue his work on fishes in connection with M. Valenciennes, who made me this proposition the day after your letter reached me. The conditions offered me are, indeed, very tempting,

but I am too little French by character, and too anxious to live in Switzerland, not to prefer the place you can offer me, however small the appointments, if they do but keep me above actual embarrassment. I say thus much only in order to answer that clause in your letter where you touch upon this question. I would add that I leave the field quite free in this respect, and that I am yours without reserve, if, indeed, within the fortnight, the urgency of the Parisians does not carry the day, or, rather, as soon as I write you that I have been able finally to withdraw. You easily understand that I cannot bluntly decline offers which seem to those who make them so brilliant. But I shall hold out against them to the utmost. My course with reference to my own publications will have shown you that I do not care for a lucrative position from personal interest; that, on the contrary, I should always be ready to use such means as I may have at my disposition for the advancement of the institution confided to my care.

My work will still detain me for four or five months at Paris, — my time being after that completely at my disposal. The period at which I should like to begin my lectures is therefore very near, and I think if your people

are favorably disposed toward the creation of a new professorship we must not let them grow cold. But you have shown me so much kindness that I may well leave to your care, in concert with your friends, the decision of this point; the more so since you are willing to take charge of my interests, until you see the success of what you are pleased to look upon as an advantage to your institution, while for me it is the realization of a sincere desire to do what I can for the advancement of science, and the instruction of our youth. . . .

The next letter from M. Coulon (June 18, 1832) announces that the sum of eighty louis having been guaranteed for three years, chiefly by private individuals, but partly also by the city, they were now able to offer a chair of natural history at once to their young countryman. In conclusion, he adds: —

"I can easily understand that the brilliant offers made you in Paris strongly counterbalance a poor little professorship of natural history at Neuchâtel, and may well cause you to hesitate; especially since your scientific career there is so well begun. On the other hand, you cannot doubt our pleasure in the prospect of having you at Neuchâtel, not only

because of the friendship felt for you by many persons here, but also on account of the lustre which a chair of natural history so filled would shed upon our institution. Of this our subscribers are well aware, and it accounts for the rapid filling of the list. I am very anxious, as are all these gentlemen, to know your decision, and beg you therefore to let us hear from you as soon as possible."

A letter from Humboldt to M. Coulon, about this time, is an earnest of his watchful care over the interests of Agassiz.

HUMBOLDT TO LOUIS COULON.

POTSDAM, *July* 25, 1832.

. . . I do not write to ask a favor, but only to express my warm gratitude for your noble and generous dealings with the young savant, M. Agassiz, who is well worthy your encouragement and the protection of your government. He is distinguished by his talents, by the variety and substantial character of his attainments, and by that which has a special value in these troubled times, his natural sweetness of disposition.

Through our common friend, M. von Buch, I have known for many years that you study natural history with a success equal to your

zeal, and that you have brought together fine collections, which you place at the disposal of others with a noble liberality. It gratifies me to see your kindness toward a young man to whom I am so warmly attached; whom the illustrious Cuvier, also, whose loss we must ever deplore, would have recommended with the same heartiness, for his faith, like mine, was based on those admirable works of Agassiz which are now nearly completed. . . .

I have strongly advised M. Agassiz not to accept the offers made to him at Paris since M. Cuvier's death, and his decision has anticipated my advice. How happy it would be for him, and for the completion of the excellent works on which he is engaged, could he this very year be established on the shores of your lake! I have no doubt that he will receive the powerful protection of your worthy governor, to whom I shall repeat my requests, and who honors me, as well as my brother, with a friendship I warmly appreciate. M. von Buch also has promised me, before leaving Berlin for Bonn and Vienna, to add his entreaty to mine. . . . He is almost as much interested as myself in M. Agassiz and his work on fossil fishes, the most important ever undertaken, and equally exact in its relation

to zoölogical characters and to geological deposits. . . .

The next letter from Agassiz to his influential friend is written after his final acceptance of the Neuchâtel professorship.

AGASSIZ TO HUMBOLDT.

PARIS, *July*, 1832.

. . . I would most gladly have answered your delightful letter at once, and have told you how smoothly all has gone at Neuchâtel. Your letters to M. de Coulon and to General von Pfüel have wrought marvels; but they are now inclined to look upon me there as a wonder from the deep,[1] and I must exert myself to the utmost lest my actual presence should give the lie to fame. It is all right. I shall be the less likely to relax in devotion to my work.

The real reason of my silence has been that I was unwilling to acknowledge so many evidences of efficient sympathy and friendly encouragement by an empty letter. I wished especially to share with you the final result of my investigations on the fossil fishes, and for that purpose it was necessary to revise my

[1] Ein blaues Meerwunder.

manuscripts and take an account of my tables in order to condense the whole in a few phrases. I have already told you that the investigation of the living fishes had suggested to me a new classification, in which families as at present circumscribed respectively received new, and to my thinking more natural positions, based upon other considerations than those hitherto brought forward. I did not at first lay any special stress on my classification. . . . My object was only to utilize certain structural characters which frequently recur among fossil forms, and which might therefore enable me to determine remains hitherto considered of little value. . . . Absorbed in the special investigation, I paid no heed to the edifice which was meanwhile unconsciously building itself up. Having however completed the comparison of the fossil species in Paris, I wanted, for the sake of an easy revision of the same, to make a list according to their succession in geological formations, with a view of determining the characteristics more exactly and bringing them by their enumeration into bolder relief. What was my joy and surprise to find that the simplest enumeration of the fossil fishes according to their geological succession was also a complete statement

of the natural relations of the families among themselves; that one might therefore read the genetic development of the whole class in the history of creation, the representation of the genera and species in the several families being therein determined; in one word, that the genetic succession of the fishes corresponds perfectly with their zoölogical classification, and with just that classification proposed by me. The question therefore in characterizing formations is no longer that of the numerical preponderance of certain genera and species, but of distinct structural relations, carried through all these formations according to a definite direction, following each other in an appointed order, and recognizable in the organisms as they are brought forth. . . . If my conclusions are not overturned or modified through some later discovery, they will form a new basis for the study of fossils. Should you communicate my discovery to others I shall be especially pleased, because it may be long before I can begin to publish it myself, and many may be interested in it. This seems to me the most important of my results, though I have also, partly from perfect specimens, partly from fragments, identified some five hundred extinct species, and

more than fifty extinct genera, beside reëstablishing three families no longer represented.

Cotta has written me in very polite terms that he could not undertake anything new at present; he would rather pay, without regard to profit, for what has been done thus far, and lets me have fifteen hundred francs. This makes it possible for me to leave Dinkel in Paris to complete the drawings. Although it often seems to me hard, I must reconcile myself to the thought of leaving investigations which are actually completed, locked up in my desk. . . .

CHAPTER VII.

1832–1834 : ÆT. 25–27.

Enters upon his Professorship at Neuchâtel. — First Lecture. — Success as a Teacher. — Love of Teaching. — Influence upon the Scientific Life of Neuchâtel. — Proposal from University of Heidelberg. — Proposal declined. — Threatened Blindness. — Correspondence with Humboldt. — Marriage. — Invitation from Charpentier. — Invitation to visit England. — Wollaston Prize. — First Number of "Poissons Fossiles." — Review of the Work.

THE following autumn Agassiz assumed the duties of his professorship at Neuchâtel. His opening lecture "Upon the Relations between the different branches of Natural History and the then prevailing tendencies of all the Sciences" was given on the 12th of November, 1832, at the Hotel de Ville. Judged by the impression made upon the listeners as recorded at the time, this introductory discourse must have been characterized by the same broad spirit of generalization which marked Agassiz's later teaching. Facts in his hands fell into their orderly relation as parts of a connected whole, and were never presented

merely as special or isolated phenomena. From the beginning his success as an instructor was undoubted. He had, indeed, now entered upon the occupation which was to be from youth to old age the delight of his life. Teaching was a passion with him, and his power over his pupils might be measured by his own enthusiasm. He was intellectually, as well as socially, a democrat, in the best sense. He delighted to scatter broadcast the highest results of thought and research, and to adapt them even to the youngest and most uninformed minds. In his later American travels he would talk of glacial phenomena to the driver of a country stage-coach among the mountains, or to some workman, splitting rock at the road-side, with as much earnestness as if he had been discussing problems with a brother geologist; he would take the common fisherman into his scientific confidence, telling him the intimate secrets of fish-structure or fish-embryology, till the man in his turn grew enthusiastic, and began to pour out information from the stores of his own rough and untaught habits of observation. Agassiz's general faith in the susceptibility of the popular intelligence, however untrained, to the highest truths of nature, was

contagious, and he created or developed that in which he believed.

In Neuchâtel the presence of the young professor was felt at once as a new and stimulating influence. The little town suddenly became a centre of scientific activity. A society for the pursuit of the natural sciences, of which he was the first secretary, sprang into life. The scientific collections, which had already attained, under the care of M. Louis Coulon, considerable value, presently assumed the character and proportions of a well-ordered museum. In M. Coulon Agassiz found a generous friend and a scientific colleague who sympathized with his noblest aspirations, and was ever ready to sustain all his efforts in behalf of scientific progress. Together they worked in arranging, enlarging, and building up a museum of natural history which soon became known as one of the best local institutions of the kind in Europe.

Beside his classes at the gymnasium, Agassiz collected about him, by invitation, a small audience of friends and neighbors, to whom he lectured during the winter on botany, on zoölogy, on the philosophy of nature. The instruction was of the most familiar and informal character, and was continued in later

years for his own children and the children of his friends. In the latter case the subjects were chiefly geology and geography in connection with botany, and in favorable weather the lessons were usually given in the open air. One can easily imagine what joy it must have been for a party of little playmates, boys and girls, to be taken out for long walks in the country over the hills about Neuchâtel, and especially to Chaumont, the mountain which rises behind it, and thus to have their lessons, for which the facts and scenes about them furnished subject and illustration, combined with pleasant rambles. From some high ground affording a wide panoramic view Agassiz would explain to them the formation of lakes, islands, rivers, springs, water-sheds, hills, and valleys. He always insisted that physical geography could be better taught to children in the vicinity of their own homes than by books or maps, or even globes. Nor did he think a varied landscape essential to such instruction. Undulations of the ground, some contrast of hill and plain, some sheet of water with the streams that feed it, some ridge of rocky soil acting as a water-shed, may be found everywhere, and the relation of facts shown perhaps as well on a small as on a large scale.

When it was impossible to give the lessons out of doors, the children were gathered around a large table, where each one had before him or her the specimens of the day, sometimes stones and fossils, sometimes flowers, fruits, or dried plants. To each child in succession was explained separately what had first been told to all collectively. When the talk was of tropical or distant countries pains were taken to procure characteristic specimens, and the children were introduced to dates, bananas, cocoa-nuts, and other fruits, not easily to be obtained in those days in a small inland town. They, of course, concluded the lesson by eating the specimens, a practical illustration which they greatly enjoyed. A very large wooden globe, on the surface of which the various features of the earth as they came up for discussion could be shown, served to make them more clear and vivid. The children took their own share in the instruction, and were themselves made to point out and describe that which had just been explained to them. They took home their collections, and as a preparation for the next lesson were often called upon to classify and describe some unusual specimen by their own unaided efforts. There was no tedium in the class. Agassiz's

lively, clear, and attractive method of teaching awakened their own powers of observation in his little pupils, and to some at least opened permanent sources of enjoyment.

His instructions to his older pupils were based on the same methods, and were no less acceptable to them than to the children. In winter his professional courses to the students were chiefly upon zoölogy and kindred topics; in the summer he taught them botany and geology, availing himself of the fine days for excursions and practical instruction in the field. Professor Louis Favre, speaking of these excursions, which led them sometimes into the gorges of the Seyon, sometimes into the forests of Chaumont, says: "They were fête days for the young people, who found in their professor an active companion, full of spirits, vigor, and gayety, whose enthusiasm kindled in them the sacred fire of science."

It was not long before his growing reputation brought him invitations from elsewhere. One of the first of these was from Heidelberg.

PROFESSOR TIEDEMANN TO LOUIS AGASSIZ.

HEIDELBERG, *December* 4, 1832.

. . . Last autumn, when I had the pleasure of meeting you in Carlsruhe, I proposed to

you to give some lectures on Natural History at this university. Professor Leuckart, who till now represented zoölogy here, is called to Freiburg, and you would therefore be the only teacher in that department. The university being so frequented, a numerous audience may be counted upon. The zoölogical collection, by no means an insignificant one, is open to your use. Professor Leuckart received a salary of five hundred florins. This is now unappropriated, and I do not doubt that the government, conformably to the proposition of the medical faculty, would give you the appointment on the same terms. By your knowledge you are prepared for the work of an able academical teacher. My advice is, therefore, that you should not bind yourself to any lyceum or gymnasium, as a permanent position; such a place would not suit a cultivated scientific man, nor does it offer a field for an accomplished scholar. Consider carefully, therefore, a question which concerns the efficiency of your life, and give me the result of your deliberation as soon as possible. Should it be favorable to the acceptance of my proposition, I hope you will find yourself here at Easter as full professor, with a salary of five hundred florins, and a fitting field of ac-

tivity for your knowledge. The fees for lectures and literary work might bring you in an additional fifteen hundred gulden yearly. If you accede to this offer send me your inaugural dissertation, and make me acquainted with your literary work, that I may take the necessary steps with the Curatorio. Consider this proposition as a proof of my high appreciation of your literary efforts and of my regard for you personally.

Agassiz's next letter to Humboldt is to consult him with respect to the call from Heidelberg, while it is also full of pleasure at the warm welcome extended to him in Neuchâtel.

AGASSIZ TO HUMBOLDT.

December, 1832.

. . . At last I am in Neuchâtel, having, indeed, begun my lectures some weeks ago. I have been received in a way I could never have anticipated, and which can only be due to your good-will on my behalf and your friendly recommendation. You have my warmest thanks for the trouble you have taken about me, and for your continued sympathy. Let me show you by my work in the years to come, rather than by words, that I am in earnest

about science, and that my spirit is not irresponsive to a noble encouragement such as you have given me.

You will have received my letter from Carlsruhe. Could I only tell you all that I have since thought and observed about the history of our earth's development, the succession of the animal populations, and their genetic classification! It cannot easily be compressed within letter limits; I will, nevertheless, attempt it when my lectures make less urgent claim upon me, and my eyes are less fatigued. I should defer writing till then were it not that to-day I have something of at least outside interest to announce. It concerns the inclosed letter received to-day. (The offer of a professorship at Heidelberg.) Should you think that I need not take it into consideration, and you have no time to answer me, let me know your opinion by your silence. I will tell you the reasons which would induce me to remain for the present in Neuchâtel, and I think you will approve them. First, as my lectures do not claim a great part of my time I shall have the more to bestow on other work; add to this the position of Neuchâtel, so favorable for observations such as I propose making on the history of development in several classes

of animals; then the hope of freeing myself from the burden of my collections; and next, the quiet of my life here with reference to my somewhat overstrained health. Beside my wish to remain, these favorable circumstances furnish a powerful motive, and then I am satisfied that people here would assist me with the greatest readiness should my publications not succeed otherwise. As to the publication of my fishes, I can, after all, better direct the lithographing of the plates here. I have just written to Cotta concerning this, proposing also that he should advance the cost of the lithographs. I shall attend to it all carefully, and be content for the present with my small means. From the gradual sale he can, little by little, repay my expenses, and I shall ask no profit until the success of the work warrants it. I await his answer. This proposal seems to me the best and the most likely to advance the publication of this work.

Since I arrived here some scientific efforts have been made with the help of M. Coulon. We have already founded a society of Natural History,[1] and I hope, should you make your promised visit next year, you will find this germ between foliage and flower at

[1] Société des Sciences Naturelles de Neuchâtel.

least, though perhaps not yet ripened into seed. . . .

M. Coulon told me the day before yesterday that he had spoken with M. de Montmollin, the Treasurer, who would write to M. Ancillon concerning the purchase of my collection. . . . Will you have the kindness, when occasion offers, to say a word to M. Ancillon about it? . . . Not only would this collection be of the greatest value to the museum here, but its sale would also advance my farther investigations. With the sum of eighty louis, which is all that is subscribed for my professorship, I cannot continue them on any large scale.

I await now with anxiety Cotta's answer to my last proposition; but whatever it be, I shall begin the lithographing of the plates immediately after the New Year, as they must be carried on under my own eye and direction. This I can well do since my uncle, Dr. Mayor in Lausanne, gives me fifty louis toward it, the amount of one year's pay to Weber, my former lithographer in Munich. I have therefore written him to come, and expect him after New Year. With my salary I can also henceforth keep Dinkel, who is now in Paris, drawing the last fossils which I described. . . .

No answer to this letter has been found beyond such as is implied in the following to M. Coulon.

HUMBOLDT TO M. COULON, FILS.

BERLIN, *January* 21, 1833.

. . . It gives me great pleasure to acknowledge the flattering welcome offered by you and your fellow-citizens to M. Agassiz, who stands so high in science, and whose intellectual qualities are enhanced by his amiable character. They write me from Heidelberg that they intend the place of M. Leuckart in zoölogy for my young friend. The choice is proposed by M. Tiedemann, and certainly nothing could be more honorable to M. Agassiz. Nevertheless, I hope that he will refuse it. He should remain for some years in your country, where a generous encouragement facilitates the publication of his work, which is of equal importance to zoölogy and geology.

I have spoken with M. Ancillon, and have left with him an official notice respecting the purchase of the Agassiz collection. The difficulty will be found, as in all human affairs, in the prose of life, in money. M. Ancillon writes me this morning: "Your paper in favor of M. Agassiz is a scientific letter of credit

which we shall try to honor. The acquisition of a superior man and a superior collection at the same time would be a double conquest for the principality of Neuchâtel. I have requested a report from the Council of State on the means of accomplishing this, and I hope that private individuals may do something toward it." Thus you see the affair is at least on the right road. I do not think, however, that the royal treasury will give at present more than a thousand Prussian crowns toward it. . . .

Regarding the invitation to Heidelberg, Agassiz's decision was already made. A letter to his brother toward the close of December mentions that he is offered a professorship at the University of Heidelberg, but that, although his answer has not actually gone, he has resolved to decline it; adding that the larger salary is counterbalanced in his mind by the hope of selling his collection at Neuchâtel, and thus freeing himself from a heavy burden.

Agassiz was now threatened with a great misfortune. Already, in Paris, his eyes had begun to suffer from the strain of microscopic work. They now became seriously impaired;

and for some months he was obliged to abate his activity, and to refrain even from writing a letter. During this time, while he was shut up in a darkened room, he practiced the study of fossils by touch alone, using even the tip of the tongue to feel out the impression, when the fingers were not sufficiently sensitive. He said he was sure at the time that he could bring himself in this way to such delicacy of touch that the loss of sight would not oblige him to abandon his work. After some months his eyes improved, and though at times threatened with a return of the same malady, he was able, throughout life, to use his eyes more uninterruptedly than most persons. His lectures, always delivered extemporaneously, do not seem to have been suspended for any length of time.

The following letter from Agassiz to Humboldt is taken from a rough and incomplete draught, which was evidently put aside (perhaps on account of the trouble in his eyes), and only completed in the following May. Although imperfect, it explains Humboldt's answer, which is not only interesting in itself, but throws light on Agassiz's work at this period.

AGASSIZ TO HUMBOLDT.

NEUCHÂTEL, *January* 27, 1833.

. . . A thousand thanks for your last most welcome letter. I can hardly tell you what pleasure it gave me, or how I am cheered and stimulated to new activity by intercourse with you on so intimate a footing. Since I wrote you, some things have become more clear to me, as, for instance, my purpose of publishing the "Fossil Fishes" here. Certain doubts remain in my mind, however, about which, as well as about other matters, I would ask your advice. Now that Cotta is dead, I cannot wait till I have made an arrangement with his successor. I therefore allow the "Fresh-Water Fishes" to lie by and drive on the others. Upon careful examination I have found, to my astonishment, that all necessary means for the publication of such a work are to be had here: two good lithographers and two printing establishments, both of which have excellent type. I have sent for Weber to engrave the plates, or draw them on stone; he will be here at the end of the month. Then I shall begin at once, and hope in May to send out the first number. The great difficulty remains now in the distribution of the numbers, and in finding a suffi-

cient sale so that they may follow each other with regularity. I think it better to begin the publication as a whole than to send out an abridgment in advance. The species can be characterized only by good illustrations. A summary always requires farther demonstration, whereas, if I give the plates at once I can shorten the text and present the general results as an introduction to the first number. With twelve numbers, of twenty plates each, followed by about ten pages of text, I can tell all that I have to say. The cost of one hundred and fifty copies printed here would, according to careful inquiry, be covered by seventy subscriptions if the price were put at one louis-d'or the number.

Now comes the question whether I should print more than one hundred and fifty copies. On account of the expense I shall not preserve the stones. For the distribution of the copies and the collecting of the money could you, perhaps, recommend me to some house in Berlin or Leipzig, who would take the work for sale in Germany on commission under reasonable conditions? For England, I wrote yesterday to Lyell, and to-morrow I shall write to Levrault and Bossange.

Both the magistrates and private individ-

uals here are now much interested in public instruction, and I am satisfied that sooner or later my collection will be purchased, though nothing has been said about it lately.[1]

For a closer description of my family of Lepidostei, to which belong all the ante-chalk bony fishes, I am anxious to have for dissection a Polypterus Bichir and a Lepidosteus osseus, or any other species belonging exclusively to the present creation. Hitherto, I have only been able to examine and describe the skeleton and external parts. If you could obtain a specimen of both for me you would do me the greatest service. If necessary, I will engage to return the preparations. I beg for this most earnestly. Forgive the many requests contained in this letter, and see in it only my ardent desire to reach my aim, in which you have already helped me so often and so kindly.

HUMBOLDT TO AGASSIZ.

SANS SOUCI, *July* 4, 1833.

. . . I am happy in your success, my dear Agassiz, happy in your charming letter of May 22d, happy in the hope of having been

[1] His collection was finally purchased by the city of Neuchâtel in the spring of 1833.

able to do something that may be useful to you for the subscription. The Prince Royal's name seemed to me rather important for you. I have delayed writing, not because I am one of the most persecuted men in Europe (the persecution goes on crescendo; there is not a scholar in Prussia or Germany having anything to ask of the King, or of M. d'Altenstein, who does not think it necessary to make me his agent, with power of attorney), but because it was necessary to await the Prince Royal's return from his military circuit, and the opportunity of speaking to him alone, which does not occur when I am with the King.

Your prospectus is full of interest, and does ample justice to those who have provided you with materials. To name me among them was an affectionate deceit, the ruse of a noble soul like yours; I am a little vexed with you about it.[1]

[1] The few words which called forth this protest from Humboldt were as follows. After naming all those from whom he had received help in specimens or otherwise, Agassiz concludes: —

"Finally, I owe to M. de Humboldt not only important notes on fossil fishes, but so many kindnesses in connection with my work that in enumerating them I should fear to wound the delicacy of the giver." This will hardly seem an exaggeration to those who know the facts of the case.

Here is the beginning of a list. I think the Department of the Mines de Province will take three or four more copies. We have not their answer yet. Do not be frightened at the brevity of the list. . . . I am, however, the least apt of all men in collecting subscriptions, seeing no one but the court, and forced to be out of town three or four days in the week. On account of this same inaptitude, I beg you to send me, through the publisher, only my own three copies, and to address the others, through the publisher also, to the individuals named on the list, merely writing on each copy that the person has subscribed on the list of M. de Humboldt.

With all my affection for you, my dear friend, it would be impossible for me to take charge of the distribution of your numbers or the returns. The publishing houses of Dümmler or of Humblot and Dunker would be useful to you at Berlin. I find it difficult to believe that you will navigate successfully among these literary corsairs! I have had a short eulogium of your work inserted in the Berliner Staats-Zeitung. You see that I do not neglect your interests, and that, for love of you, I even turn journalist. You have omitted to state in your prospectus whether

your plates are lithographed, as I fear they are, and also whether they are colored, which seems to me unnecessary. Have your superb original drawings remained in your possession, or are they included in the sale of your collection? . . .

I could not make use of your letter to the King, and I have suppressed it. You have been ill-advised as to the forms. "Erhabener König" has too poetical a turn; we have here the most prosaic and the most degrading official expressions. M. de Pfüel must have some Arch-Prussian with him, who would arrange the formula of a letter for you. At the head there must be "Most enlightened, most powerful King, — all gracious sovereign and lord." Then you begin, "Your Royal Majesty, deeply moved, I venture to lay at your feet most humbly my warmest thanks for the support so graciously granted to the purchase of my collection for the Gymnasium in Neuchâtel. Did I know how to write," etc. The rest of your letter was very good; put only "so much grace as to answer" instead of "so much kindness." You should end with the words, "I remain till death, in deepest reverence, the most humble and faithful servant of your Royal Majesty." The whole on small folio,

sealed, addressed outside, "To the King's Majesty, Berlin." Send the letter, not through me, but officially, through M. de Pfüel.[1]

The letter to the King is not absolutely necessary, but it will give pleasure, for the King likes any affectionate demonstration from the country that has now become yours.[2] It will be useful, also, with reference to our request for the purchase of some copies, which we will make to the King as soon as the first number has appeared. Had I obtained the King's name for you to-day (which would have been difficult, since the King detests subscriptions), we should have spoiled the sequence. It seems to me that a letter of acknowledg-

[1] At the head there must be "Allerdurchlauchtigster, grossmächtigster König, — allergnädigster König und Herr." Then you begin, "Euer königlichen Majestät, wage ich meinen lebhaftesten Dank für die allergnädigst bewilligte Unterstützung zum Ankauf meiner Sammlung für das Gymnasium in Neuchâtel tief gerührt allerunterthänigst zu Füssen zu legen. Wüsste ich zu schreiben," etc. The rest of your letter was very good, — put only, "so vieler Gnade zu entsprechen" instead of "so vieler Güte." You should end with the words, "Ich ersterbe in tiefster Ehrfurcht Euer königlicher Majestät aller unter thänigsten getreuester." The whole on small folio, sealed, addressed outside, "An des König's Majestät, Berlin."

These forms are no longer in use. They belong to a past generation.

[2] It may not be known to all readers that Neuchâtel was then under Prussian sovereignty.

ment from you to M. Ancillon would be very suitable also. Do not think it is too late. One addresses him as "Monsieur et plus votre Excellence." I am writing the most pedantic letter in the world in answer to yours, so full of charm. It must seem to you absurd that I write you in French, when you, French by origin, or rather by language, prefer to write me in German. Pray tell me, did you learn German, which you write with such purity, as a child?

I am happy to see that you publish the whole together. The parceling out of such a work would have led to endless delays; but, for mercy's sake, take care of your eyes; they are *ours*. I have not neglected the subscriptions in Russia, but I have, as yet, no answer. At a venture, I have placed the name of M. von Buch on my list. He is absent; it is said that he will go to Greece this summer. Pray make it a rule not to give away copies of your work. If you follow that inclination you will be pecuniarily ruined.

I wish I could have been present at your course of lectures. What you tell me of them delights me, though I am ready to do battle with you about those metamorphoses of our globe which have even slipped into your title.

I see by your letter that you cling to the idea of internal vital processes of the earth, that you regard the successive formations as different phases of life, the rocks as products of metamorphosis. I think this symbolical language should be employed with great reserve. I know that point of view of the old "Naturphilosophie;" I have examined it without prejudice, but nothing seems to me more dissimilar than the vital action of the metamorphosis of a plant in order to form the calyx or the flower, and the successive formation of beds of conglomerate. There is order, it is true, in the superposed beds, sometimes an alternation of the same substance, an interior cause, — sometimes even a successive development, starting from a central heat; but can the term *life* be applied to this kind of movement? Limestone does not generate sandstone. I do not know that there exists what physiologists call a vital force, different from, or opposed to, the physical forces which we recognize in all matter; I think the vital process is only a particular mode of action, of limitation of those physical forces; action, the nature of which we have not yet fully sounded. I believe there are nervous storms (electric) like those which set fire to the atmosphere,

but that special action which we call organic, in which every part becomes cause or effect, seems to me distinct from the changes which our planet has undergone. I pause here, for I feel that I must annoy you, and I care for you too much to run that risk. Moreover, a superior man like yourself, my dear friend, floats above material things and leaves a margin for philosophic doubt.

Farewell; count on the little of life that remains to me, and on my affectionate devotion. At twenty-six years of age, and possessed of so much knowledge, you are only entering upon life, while I am preparing to depart; leaving this world far different from what I hoped it would be in my youth. I will not forget the Bichir and the Lepidosteus. Remember always that your letters give me the greatest pleasure. . . .

[P. S.] Look carefully at the new number of Poggendorf, in which you will find beautiful discoveries of Ehrenberg (microscopical) on the difference of structure between the brain and the nerves of motion, also upon the crystals forming the silvered portion of the peritoneum of Esox lucius.

In October, 1833, Agassiz's marriage to Cecile Braun, the sister of his life-long friend, Alexander Braun, took place. He brought his wife home to a small apartment in Neuchâtel, where they began their housekeeping after the simplest fashion, with such economy as their very limited means enforced. Her rare artistic talent, hitherto devoted to her brother's botanical pursuits, now found a new field. Trained to accuracy in drawing objects of Natural History, she had an artist's eye for form and color. Some of the best drawings in the Fossil Fishes and the Fresh-Water Fishes are from her hand. Throughout the summer, notwithstanding the trouble in his eyes, Agassiz had been still pressing on these works. His two artists, Mr. Dinkel and Mr. Weber, the former in Paris, the latter in Neuchatel, were constantly busy on his plates.

Although Agassiz was at this time only twenty-six years of age, his correspondence already shows that the interest of scientific men, all over Europe, was attracted to him and to his work. From investigators of note in his own country, from those of France, Italy, and Germany, from England, and even from America, the distant El Dorado of naturalists in those days, came offers of coöpera-

tion, accompanied by fossil fishes or by the drawings of rare or unique specimens. He was known in all the museums of Europe as an indefatigable worker and collector, seeking everywhere materials for comparison.

Among the letters of this date is one from Charpentier, one of the pioneers of glacial investigation, under whose auspices, two years later, Agassiz began his inquiries into glacial phenomena. He writes him from the neighborhood of Bex, his home in the valley of the Rhone, the classic land of glacial work; but he writes of Agassiz's special subjects, inviting him to come and see such fossils as were to be found in his neighborhood, and to investigate certain phenomena of upheaval and of plutonic action in the same region, little dreaming that the young zoölogist was presently to join him in his own chosen field of research.

Agassiz now began also to receive pressing invitations from the English naturalists, from Buckland, Lyell, Murchison, and others, to visit England, and examine their wonderful collections of fossil remains.

FROM PROFESSOR BUCKLAND TO AGASSIZ.

OXFORD, *December* 25, 1833.

. . . I should very much like to put into your hands what few materials I possess in the Oxford Museum relating to fossil fishes, and am also desirous that you should see the fossil fish in the various provincial museums of England, as well as in London. Sir Philip Egerton has a very large collection of fishes from Engi and Oeningen, which he wishes to place at your disposition. Like myself, he would willingly send you drawings, but drawings made without knowledge of the anatomical details which you require, cannot well represent what the artist himself does not perceive. I would willingly lend you my specimens, if I could secure them against the barbarous hands of the custom-house officials. What I would propose to you as a means of seeing all the collections of England, and gaining at the same time additional subscriptions for your work, is, that you should come to England and attend the British Association for the Advancement of Science in September next. There you will meet all the naturalists of England, and I do not doubt that among them you will find a good many

subscribers. You will likewise see a new mine of fossil fishes in the clayey schist of the coal formation at Newhaven, on the banks of the Forth, near Edinburgh. You can also make arrangements to visit the museums of York, Whitby, Scarborough, and Leeds, as well as the museum of Sir Philip Egerton, on your way to and from Edinburgh. You may, likewise, visit the museums of London, Cambridge, and Oxford; everywhere there are fossil fishes; and traveling by coach in England is so rapid, easy, and cheap, that in six weeks or less you can accomplish all that I have proposed. As I seriously hope that you will come to England for the months of August and September, I say nothing at present of any other means of putting into your hands the drawings or specimens of our English fossil fishes. I forgot to mention the very rich collection of fossil fishes in the Museum of Mr. Mantell, at Brighton, where, I think, you could take the weekly steam-packet for Rotterdam as easily as in London, and thus arrive in Neuchâtel from London in a very few days. . . .

AGASSIZ TO PROFESSOR BUCKLAND.

. . . I thank you most warmly for the very important information you have so kindly given me respecting the rich collections of England; I will, if possible, make arrangements to visit them this year, and in that case I will beg you to let me have a few letters of recommendation to facilitate my examination of them in detail. Not that I question for a moment the liberality of the English naturalists. All the continental savants who have visited your museums have praised the kindness shown in intrusting to them the rarest objects, and I well know that the English rival other nations in this respect, and even leave them far behind. But one must have merited such favors by scientific labors; to a beginner they are always a free gift, wholly undeserved. . . .

A few months later Agassiz received a very gratifying and substantial mark of the interest felt by English naturalists in his work.

CHARLES LYELL TO LOUIS AGASSIZ.

SOMERSET HOUSE, LONDON, *February* 4, 1834.

. . . It is with the greatest pleasure that I announce to you good news. The Geolog-

ical Society of London desires me to inform you that it has this year conferred upon you the prize bequeathed by Dr. Wollaston. He has given us the sum of one thousand pounds sterling, begging us to expend the interest, or about seven hundred and fifty francs every year, for the encouragement of the science of geology. Your work on fishes has been considered by the Council and the officers of the Geological Society worthy of this prize, Dr. Wollaston having said that it could be given for unfinished works. The sum of thirty guineas, or £31 10*s.* sterling, has been placed in my hands, but I would not send you the money before knowing exactly where you were and learning from you where you wish it to be paid. You will probably like an order on some Swiss banker.

I cannot yet give you the extract from the address of the President in which your work is mentioned, but I shall have it soon. In the mean time I am desired to tell you that the Society declines to receive your magnificent work as a gift, but wishes to subscribe for it, and has already ordered a copy from the publishers. . . .

AGASSIZ TO LYELL.

NEUCHÂTEL, *March* 25, 1834.

. . . You cannot imagine the joy your letter has given me. The prize awarded to me is at once so unexpected an honor and so welcome an aid that I could hardly believe my eyes when, with tears of relief and gratitude, I read your letter. In the presence of a savant, I need not be ashamed of my penury, since I have spent the little I had, wholly in scientific researches. I do not, therefore, hesitate to confess to you that at no time could your gift have given me greater pleasure. Generous friends have helped me to bring out the first number of my "Fossil Fishes;" the plates of the second are finished, but I was greatly embarrassed to know how to print a sufficient number of copies before the returns from the first should be paid in. The text is ready also, so that now, in a fortnight, I can begin the distribution, and, the rotation once established, I hope that preceding numbers will always enable me to publish the next in succession without interruption. I even count upon this resource as affording me the means of making a journey to England before long. If no obstacle arises I hope to accomplish this

during the coming summer, and to be present at the next meeting of the English naturalists.

I do not live the less happily on account of my anxieties, but I am sometimes obliged to work more than I well can, or ought in reason to do. . . . The second number of my "Fossil Fishes" contains the beginning of the anatomy of the fishes, but only such portions as are to be found in the fossil state. I have begun with the scales; later, I treat of the bones and the teeth. Then comes the continuation of the description of the Ganoids and the Scomberoids, and an additional sheet contains a sketch of my ichthyological classification. The plates are even more successful than those of the first number. If all goes well the third number will appear next July. I long to visit your rich collections; I hope that whenever it becomes possible for me to do so, I shall have the good fortune to find you in London. . . .

I have thought a letter addressed to the President of the Society in particular, and to the members in general, would be fitting. Will you have the kindness to deliver it for me to Mr. Murchison?

The first number of the "Fossil Fishes" had already appeared, and had been greeted with enthusiasm by scientific men. Elie de Beaumont writes Agassiz in June, 1834: "I have read with great pleasure your first number; it promises us a work as important for science as it is remarkable in execution. Do not let yourself be discouraged by obstacles of any kind; they will give way before the concert of approbation which so excellent a work will awaken. I shall always be glad to aid in overcoming any one of them."

Perhaps it is as well to give here a slight sketch of this work, the execution of which was carried on during the next ten years (1833–1843). The inscription tells, in few words, the author's reverence for Humboldt and his personal gratitude to him. "These pages owe to you their existence; accept their dedication." The title gives in a broad outline the comprehensive purpose of the work:

"Researches on the Fossil Fishes: comprising an Introduction to the Study of these Animals; the Comparative Anatomy of Organic Systems which may contribute to facilitate the Determination of Fossil Species; a New Classification of Fishes expressing their Relations to the Series of Formations; the Explanation of

the Laws of their Succession and Development during all the Changes of the Terrestrial Globe, accompanied by General Geological Considerations; finally, the Description of about a thousand Species which no longer exist, and whose Characters have been restored from Remains contained in the Strata of the Earth."

The most novel results comprised in this work were: first, the remodeling of the classification of the whole type of fishes, fossil and living, and especially the separation of the Ganoids from all other fishes, under the rank of a distinct order; second, the recognition of those combinations of reptilian and bird-like characters in the earlier geological fishes, which led the author to call them prophetic types; and third, his discovery of an analogy between the embryological phases of the higher present fishes and the gradual introduction of the whole type on earth, the series in growth and the series in time revealing a certain mutual correspondence. As these comprehensive laws have thrown light upon other types of the animal kingdom beside that of fishes, their discovery may be said to have advanced general zoölogy as well as ichthyology.

The Introduction presents, as it were, the prelude to this vast chapter of natural history in the simultaneous appearance of the four great types of the animal kingdom: Radiates, Mollusks, Articulates, and Vertebrates. Then comes the orderly development of the class by which the vertebrate plan was first expressed, namely, the fishes. Underlying all its divisions and subdivisions, is the average expression of the type in the past and present; the Placoids and Ganoids, with their combination of reptilian and fishlike features, characterizing the earlier geological epochs, while in the later the simple bony fishes, the Cycloids and Ctenoids, take the ascendency. Here, for the first time, Agassiz presents his "synthetic or prophetic types," namely, early types embracing, as it were, in one large outline, features afterward individualized in special groups, and never again reunited. No less striking than these general views of structural relations are the clearness and simplicity with which the distribution of the whole class of fishes in relation to the geological formations, or, in other words, to the physical history of the earth, is shown. In reading this introductory chapter, one familiar with Agassiz as a public teacher will almost hear his voice marshaling the long

procession of living beings, as he was wont to do, in their gradual introduction upon the earth. Indeed, his whole future work in ichthyology, and one might almost say in general zoölogy, was here sketched.

The technicalities of this work, at once so comprehensive in its combinations and so minute in its details, could interest only the professional reader, but its generalizations may well have a certain attraction for every thoughtful mind. It treats of the relations, anatomical, zoölogical, and geological, between the whole class of fishes, fossil and living, illustrated by numerous plates, while additional light is thrown on the whole by the revelations of embryology.

"Notwithstanding these striking differences," says the author in the opening of the fifth chapter on the relations of fishes in general, "it is none the less evident to the attentive observer that one single idea has presided over the development of the whole class, and that all the deviations lead back to a primary plan, so that even if the thread seem broken in the present creation, one can reunite it on reaching the domain of fossil ichthyology." [1]

Having shown how the present creation has

[1] Vol. i. chapter v. pp. 92, 93.

given him the key to past creations, how the complete skeleton of the living fishes has explained the scattered fragments of the ancient ones, especially those of which the soft cartilaginous structure was liable to decay, he presents two modes of studying the type as a whole; either in its comparative anatomy, including in the comparison the whole history of the type, fossil and living, or in its comparative embryology. "The results," he adds, "of these two methods of study complete and control each other." In all his subsequent researches indeed, the history of the individual in its successive phases went hand in hand with the history of the type. He constantly tested his zoölogical results by his embryological investigations.

After a careful description of the dorsal chord in its embryological development, he shows that a certain parallelism exists between the comparative degrees of development of the vertebral column in the different groups of fishes, and the phases of its embryonic development in the higher fishes. Farther on he shows a like coincidence between the development of the system of fins in the different groups of fishes, and the gradual growth and differentiation of the fins in the embryo of the

higher living fishes.[1] "There is, then," he concludes, "as we have said above, a certain analogy, or rather a certain parallelism, to be established between the embryological development of the Cycloids and Ctenoids, and the genetic or paleontological development of the whole class. Considered from this point of view, no one will dispute that the form of the caudal fin is of high importance for zoölogical and paleontological considerations, since it shows that the same thought, the same plan, which presides to-day over the formation of the embryo, is also manifested in the successive development of the numerous creation which have formerly peopled the earth." Agassiz says himself in his Preface: "I have succeeded in expressing the laws of succession and of the organic development of fishes during all geological epochs; and science may henceforth, in seeing the changes of this class from formation to formation, follow the progress of organization in one great division of the animal kingdom, through a complete series of the ages of the earth." This is not inconsistent with his position as the leading opponent of the development or Darwinian

[1] *Recherches sur les Poissons Fossiles*, vol. i. chapter v. p. 102.

theories. To him, development meant development of plan as expressed in structure, not the change of one structure into another. To his apprehension the change was based upon intellectual, not upon material causes. He sums up his own conviction with reference to this question as follows:[1] "Such facts proclaim aloud principles not yet discussed in science, but which paleontological researches place before the eyes of the observer with an ever-increasing persistency. I speak of the relations of the creation with the creator. Phenomena closely allied in the order of their succession, and yet without sufficient cause in themselves for their appearance; an infinite diversity of species without any common material bond, so grouping themselves as to present the most admirable progressive development to which our own species is linked,— are these not incontestable proofs of the existence of a superior intelligence whose power alone could have established such an order of things? . . .

"More than fifteen hundred species of fossil fishes, which I have learned to know, tell me that species do not pass insensibly one into

[1] *Recherches sur les Poissons Fossiles*, vol. i. chapter vi. pp. 171, 172. "Essay on the Classification of Fishes."

another, but that they appear and disappear unexpectedly, without direct relations with their precursors; for I think no one will seriously pretend that the numerous types of Cycloids and Ctenoids, almost all of which are contemporaneous with one another, have descended from the Placoids and Ganoids. As well might one affirm that the Mammalia, and man with them, have descended directly from fishes. All these species have a fixed epoch of appearance and disappearance; their existence is even limited to an appointed time. And yet they present, as a whole, numerous affinities more or less close, a definite coördination in a given system of organization which has intimate relations with the mode of existence of each type, and even of each species. An invisible thread unwinds itself throughout all time, across this immense diversity, and presents to us as a definite result, a continual progress in the development of which man is the term, of which the four classes of vertebrates are intermediate forms, and the totality of invertebrate animals the constant accessory accompaniment."

The difficulty of carrying out comparisons so rigorous and extensive as were needed in order to reconstruct the organic relations be-

tween the fossil fishes of all geological formations and those of the present world, is best told by the author.[1] "Possessing no fossil fishes myself, and renouncing forever the acquisition of collections so precious, I have been forced to seek the materials for my work in all the collections of Europe containing such remains; I have, therefore, made frequent journeys in Germany, in France, and in England, in order to examine, describe, and illustrate the objects of my researches. But notwithstanding the cordiality with which even the most precious specimens have been placed at my disposition, a serious inconvenience has resulted from this mode of working, namely, that I have rarely been able to compare directly the various specimens of the same species from different collections, and that I have often been obliged to make my identification from memory, or from simple notes, or, in the more fortunate cases, from my drawings only. It is impossible to imagine the fatigue, the exhaustion of all the faculties, involved in such a method. The hurry of traveling, joined to the lack of the most ordinary facilities for observation, has not rendered my task more

[1] *Recherches sur les Poissons Fossiles*, vol. i. Addition à la Préface.

easy. I therefore claim indulgence for such of my identifications as a later examination, made at leisure, may modify, and for descriptions which sometimes bear the stamp of the precipitation with which they have been prepared."

It was, perhaps, this experience of Agassiz's earlier life which made him so anxious to establish a museum of comparative zoölogy in this country, — a museum so abundant and comprehensive in material, that the student should not only find all classes of the animal kingdom represented within its walls, but preserved also in such numbers as to allow the sacrifice of many specimens for purposes of comparison and study. He was resolved that no student should stand there baffled at the door of knowledge, as he had often done himself, when shown the one precious specimen, which could not be removed, or even examined on the spot, because unique.

CHAPTER VIII.

1834–1837: ÆT. 27–30.

First Visit to England. — Reception by Scientific Men. — Work on Fossil Fishes there. — Liberality of English Naturalists. — First Relations with American Science. — Farther Correspondence with Humboldt. — Second Visit to England. — Continuation of "Fossil Fishes." — Other Scientific Publications. — Attention drawn to Glacial Phenomena. — Summer at Bex with Charpentier. — Sale of Original Drawings for "Fossil Fishes." — Meeting of Helvetic Society. — Address on Ice-Period. — Letters from Humboldt and Von Buch.

In August, 1834, according to his cherished hope, Agassiz went to England, and was received by the scientific men with a cordial sympathy which left not a day or an hour of his short sojourn there unoccupied. The following letter from Buckland is one of many proffering hospitality and friendly advice on his arrival.

DR. BUCKLAND TO LOUIS AGASSIZ.

Oxford, *August* 26, 1834.

. . . I am rejoiced to hear of your safe arrival in London, and write to say that I am

in Oxford, and that I shall be most happy to receive you and give you a bed in my house if you can come here immediately. I expect M. Arago and Mr. Pentland from Paris tomorrow (Wednesday) afternoon. I shall be most happy to show you our Oxford Museum on Thursday or Friday, and to proceed with you toward Edinburgh. Sir Philip Egerton has a fine collection of fossil fishes near Chester, which you should visit on your road. I have partly engaged myself to be with him on Monday, September 1st, but I think it would be desirable for you to go to him Saturday, that you may have time to take drawings of his fossil fishes.

I cannot tell certainly what day I shall leave Oxford until I see M. Arago, whom I hope you will meet at my house, on your arrival in Oxford. I shall hope to see you Wednesday evening or Thursday morning. Pray come to my house in Christ Church, with your baggage, the moment you reach Oxford. . . .

Agassiz always looked back with delight on this first visit to Great Britain. It was the beginning of his life-long friendship with Buckland, Sedgwick, Murchison, Lyell, and

others of like pursuits and interests. Made welcome in many homes, he could scarcely respond to all the numerous invitations, social and scientific, which followed the Edinburgh meeting.

Guided by Dr. Buckland, to whom not only every public and private collection, but every rare specimen in the United Kingdom, seems to have been known, he wandered from treasure to treasure. Every day brought its revelation, until, under the accumulation of new facts, he almost felt himself forced to begin afresh the work he had believed well advanced. He might have been discouraged by a wealth of resources which seemed to open countless paths, leading he knew not whither, but for the generosity of the English naturalists who allowed him to cull, out of sixty or more collections, two thousand specimens of fossil fishes, and to send them to London, where, by the kindness of the Geological Society, he was permitted to deposit them in a room in Somerset House. The mass of materials once sifted and arranged, the work of comparison and identification became comparatively easy. He sent at once for his faithful artist, Mr. Dinkel, who began, without delay, to copy all such specimens as

threw new light on the history of fossil fishes, a work which detained him in England for several years.

Agassiz made at this time two friends, whose sympathy and coöperation in his scientific work were invaluable to him for the rest of his life. Sir Philip Egerton and Lord Cole (Earl of Enniskillen) owned two of the most valuable collections of fossil fishes in Great Britain.[1] To aid him in his researches, their most precious specimens were placed at Agassiz's disposition; his artist was allowed to work for months on their collections, and even after Agassiz came to America, they never failed to share with him, as far as possible, the advantages arising from the increase of their museums. From this time his correspondence with them, and especially with Sir Philip Egerton, is closely connected with the ever-growing interest as well as with the difficulties of his scientific career. Reluctantly, and with many a backward look, he left England in October, and returned to his lectures in Neuchâtel, taking with him such specimens as were indispensable to the progress of his work. Every hour of the following winter which could be spared from his lectures was devoted to his fossil fishes.

[1] Now the property of the British Museum.

A letter of this date from Professor Silliman, of New Haven, Connecticut, marks the beginning of his relations with his future New England home, and announces his first New England subscribers.

YALE COLLEGE NEW HAVEN,
UNITED STATES OF N. AMERICA, *April* 22, 1835.

. . . From Boston, March 6th, I had the honor to thank you for your letter of January 5th, and for your splendid present of your great work on fossil fishes — livraison 1 – 22 — received, with the plates. I also gave a notice of the work in the April number of the Journal[1] (this present month), and republished Mr. Bakewell's account of your visit to Mr. Mantell's museum.

In Boston I made some little efforts in behalf of your work, and have the pleasure of naming as follows : —

Harvard University, Cambridge (Cambridge is only four miles from Boston), by Hon. Josiah Quincy, President.

Boston Athenæum, by its Librarian.

Benjamin Green, Esq., President of the Boston Natural History Society.

I shall make application to some other insti-

[1] *The American Journal of Science and Arts.*

tutions or individuals, but do not venture to promise anything more than my best exertions. . . .

Agassiz little dreamed, as he read this letter, how familiar these far-off localities would become to him, or how often, in after years, he would traverse by day and by night the four miles which lay between Boston and his home in Cambridge.

Agassiz still sought and received, as we see by the following letter, Humboldt's sympathy in every step of his work.

HUMBOLDT TO LOUIS AGASSIZ.

BERLIN, *May*, 1835.

I am to blame for my neglect of you, my dear friend, but when you consider the grief which depresses me,[1] and renders me unfit to keep up my scientific connections, you will not be so unkind as to bear me any ill-will for my long silence. You are too well aware of my high esteem for your talents and your character — you know too well the affectionate friendship I bear you — to fear for a moment that you could be forgotten.

I have seen the being I loved most, and

[1] Owing to the death of his brother, William von Humboldt

who alone gave me some interest in this arid land, slowly decline. For four long years my brother had suffered from a weakness of all the muscles, which made me always fear that the seat of the trouble was the *medulla oblongata*. Yet his step was firm; his head was entirely clear. The higher intellectual faculties retained all their energy. He was engaged from twelve to thirteen hours a day on his works, reading or rather dictating, for a nervous trembling of the hand prevented him from using a pen. Surrounded by a numerous family; living on a spot created, so to speak, by himself, and in a house which he had adorned with antique statues; withdrawn also from affairs, he was still attached to life. The illness which carried him off in ten days — an inflammation of the chest — was but a secondary symptom of his disease. He died without pain, with a strength of character and a serenity of mind worthy of the greatest admiration. It is cruel to see so noble an intelligence struggle during ten long days against physical destruction. We are told that in great grief we should turn with redoubled energy to the study of nature. The advice is easy to give; but for a long time even the wish for distraction is wanting.

My brother leaves two works which we intend to publish: one upon the languages and ancient Indian civilization of the Asiatic archipelago, and the other upon the structure of languages in general, and the influence of that structure upon the intellectual development of nations. This last work has great beauty of style. We shall soon begin the publication of it. My brother's extensive correspondence with all those countries over which his philological studies extended brings upon me just at present, such a multiplicity of occupations and duties that I can only write you these few lines, my dear friend, as a pledge of my constant affection, and, I may also add, my admiration of your eminent works. It is a pleasure to watch the growing renown of those who are dear to us; and who should merit success more than you, whose elevation of character is proof against the temptations of literary self-love? I thank you for the little you have told me of your home life. It is not enough to be praised and recognized as a great and profound naturalist; to this one must add domestic happiness as well. . . .

I am about finishing my long and weari-some work of (illegible); a critical examination into the geography of the Middle Ages, of

which fifty sheets are already printed. I will send you the volumes as soon as they appear, in octavo. I devoured your fourth number; the plates are almost finer than the previous ones; and the text, though I have only looked it through hastily, interested me deeply, especially the analytical catalogue of Bolca, and the more general and very philosophical views of fishes in general, pp. 57–64. The latter is also remarkable in point of style. . . .

M. von Buch, who has just left me, sends you a warm greeting. None the less does he consider the method of issuing your text in fragments from different volumes, altogether diabolical. I also complain a little, though in all humility; but I suppose it to be connected with the difficulty of concluding any one family, when new materials are daily accumulating on your hands. Continue then as before. In my judgment, M. Agassiz never does wrong. . . .

The above letter, though written in May, did not reach Agassiz until the end of July, when he was again on his way to England, where his answer is dated.

AGASSIZ TO HUMBOLDT.

(LONDON), *October* —, 1835.

. . . I cannot express to you my pleasure in reading your letter of May 10th (which was, unhappily, only delivered to me on my passage through Carlsruhe, at the end of July). . . . To know that I have occupied your thoughts a moment, especially in days of trial and sorrow such as you have had to bear, raises me in my own eyes, and redoubles my hope for the future. And just now such encouragement is particularly cheering under the difficulties which I meet in completing my task in England. I have now been here nearly two months, and I hope before leaving to finish the description of all that I brought together at the Geological Society last year. Knowing that you are in Paris, however, I cannot resist the temptation of going to see you; indeed, should your stay be prolonged for some weeks, it would be my most direct path for home. I should like to tell you a little of what I have done, and how the world has gone with me since we last met. . . . I have certainly committed an imprudence in throwing myself into an enterprise so vast in proportion to my means as my "Fossil

Fishes." But, having begun it, I have no alternative; my only safety is in success. I have a firm conviction that I shall bring my work to a happy issue, though often in the evening I hardly know how the mill is to be turned to-morrow. . . .

By a great good fortune for me, the British Association, at the suggestion of Buckland, Sedgwick, and Murchison, has renewed, for the present year, its vote of one hundred guineas toward the facilitating of researches upon the fossil fishes of England, and I hope that a considerable part of this sum may be awarded to me, in which case I may be able to complete the greater number of the drawings I need. If I had obtained in France only half the subscriptions I have had in England, I should be afloat; but thus far M. Baillière has only disposed of some fifteen copies. . . . My work advances fairly; I shall soon have described all the species I know, numbering now about nine hundred. I need some weeks in Paris for the comparison of several tertiary species with living ones in order to satisfy myself of their specific identity, and then my task will be accomplished. Next comes the putting in order of all my notes. My long vacations will give me time to do this with the greatest care. . . .

His second visit to England, during which the above letter was written, was chiefly spent in reviewing the work of his artist, whom he now reinforced with a second draughtsman, M. Weber, the same who had formerly worked with him in Munich. He also attended the meeting of the British Association in Dublin, stayed a few days at Oulton Park for another look at the collections of Sir Philip Egerton, made a second grand tour among the other fossil fishes of England and Ireland, and returned to Neuchâtel, leaving his two artists in London with their hands more than full.

While Agassiz thus pursued his work on fossil fishes with ardor and an almost perilous audacity, in view of his small means, he found also time for various other investigations. During the year 1836, though pushing forward constantly the publication of the "Poissons Fossiles," his "Prodromus of the Class of Echinodermata" appeared in the Memoirs of the Natural History Society of Neuchâtel, as well as his paper on the fossil Echini belonging to the Neocomien group of the Neuchâtel Jura, accompanied by figures. Not long after, he published in the Memoirs of the Helvetic Society his descriptions of fossil Echini peculiar to Switzerland, and issued also the first

number of a more extensive work, "Monographie d'Echinodermes." During this year he received a new evidence of the sympathy of the English naturalists, in the Wollaston medal awarded to him by the London Geological Society.

The summer of 1836 was an eventful one for Agassiz, — the opening, indeed, of a new and brilliant chapter in his life. The attention of the ignorant and the learned had alike been called to the singular glacial phenomena of movement and transportation in the Alpine valleys. The peasant had told his strange story of boulders carried on the back of the ice, of the alternate retreat and advance of glaciers, now shrinking to narrower limits, now plunging forward into adjoining fields, by some unexplained power of expansion and contraction. Scientific men were awake to the interest of these facts, but had considered them only as local phenomena. Venetz and Charpentier were the first to detect their wider significance. The former traced the ancient limits of the Alpine glaciers as defined by the frame-work of débris or loose material they had left behind them; and Charpentier went farther, and affirmed that all the erratic boulders scattered over the plain of Switzer-

land and on the sides of the Jura had been thus distributed by ice and not by water, as had been supposed.

Agassiz was among those who received this hypothesis as improbable and untenable. Still, he was anxious to see the facts in place, and Charpentier was glad to be his guide. He therefore passed his vacation, during this summer of 1836, at the pretty town of Bex, in the valley of the Rhone. Here he spent a number of weeks in explorations, which served at the same time as a relaxation from his more sedentary work. He went expecting to confirm his own doubts, and to disabuse his friend Charpentier of his errors. But after visiting with him the glaciers of the Diablerets, those of the valley of Chamounix, and the moraines of the great valley of the Rhone and its principal lateral valleys, he came away satisfied that a too narrow interpretation of the phenomena was Charpentier's only mistake.

During this otherwise delightful summer, he was not without renewed anxiety lest he should be obliged to suspend the publication of the Fossil Fishes for want of means to carry it on. On this account he writes from Bex to Sir Philip Egerton in relation to the sale of his original drawings, the only property he pos-

sessed. "It is absolutely impossible," he says, "for me to issue even another number until this sale is effected. . . . I shall consider myself more than repaid if I receive, in exchange for the whole collection of drawings, simply what I have expended upon them, provided I may keep those which have yet to be lithographed until that be done."

Sir Philip made every effort to effect a sale to the British Museum. He failed at the moment, but the collection was finally purchased and presented to the British Museum by a generous relative of his own, Lord Francis Egerton. In the mean time, Sir Philip and Lord Cole, in order to make it possible for Agassiz to retain the services of Mr. Dinkel, proposed to pay his expenses while he was drawing such specimens from their own collections as were needed for the work. These drawings were, of course, finally to remain their own property.

During his sojourn at Bex, Agassiz's intellect and imagination had been deeply stirred by the glacial phenomena. In the winter of 1837, on his return to Neuchâtel, he investigated anew the slopes of the Jura, and found that the facts there told the same story. Although he resumed with unabated ardor his

various works on fishes, radiates, and mollusks, a new chapter of nature was all the while unfolding itself in his fertile brain. When the Helvetic Association assembled at Neuchâtel in the following summer, the young president, from whom the members had expected to hear new tidings of fossil fishes, startled them by the presentation of a glacial theory, in which the local erratic phenomena of the Swiss valleys assumed a cosmic significance. It is worthy of remark here that the first large outlines in which Agassiz, when a young man, planned his intellectual work gave the key-note to all that followed. As the generalizations on which all his future zoölogical researches were based, are sketched in the Preface to his "Poissons Fossiles," so his opening address to the Helvetic Society in 1837 unfolds the glacial period as a whole, much as he saw it at the close of his life, after he had studied the phenomena on three continents. In this address he announced his conviction that a great ice-period, due to a temporary oscillation of the temperature of the globe, had covered the surface of the earth with a sheet of ice, extending at least from the north pole to Central Europe and Asia. "Siberian winter," he says, "established itself

for a time over a world previously covered with a rich vegetation and peopled with large mammalia, similar to those now inhabiting the warm regions of India and Africa. Death enveloped all nature in a shroud, and the cold, having reached its highest degree, gave to this mass of ice, at the maximum of tension, the greatest possible hardness." In this novel presentation the distribution of erratic boulders, instead of being classed among local phenomena, was considered "as one of the accidents accompanying the vast change occasioned by the fall of the temperature of our globe before the commencement of our epoch."

This was, indeed, throwing the gauntlet down to the old expounders of erratic phenomena upon the principle of floods, freshets, and floating ice. Many well-known geologists were present at the meeting, among them Leopold von Buch, who could hardly contain his indignation, mingled with contempt, for what seemed to him the view of a youthful and inexperienced observer. One would have liked to hear the discussion which followed, in special section, between Von Buch, Charpentier, and Agassiz. Elie de Beaumont, who should have made the fourth, did not arrive till later. Difference of opinion, however, never dis-

turbed the cordial relation which existed between Von Buch and his young opponent. Indeed, Agassiz's reverence and admiration for Von Buch was then, and continued throughout his life, deep and loyal.

Not alone from the men who had made these subjects their special study, did Agassiz meet with discouragements. The letters of his beloved mentor, Humboldt, in 1837, show how much he regretted that any part of his young friend's energy should be diverted from zoölogy, to a field of investigation which he then believed to be one of theory rather than of precise demonstration. He was, perhaps, partly influenced by the fact that he saw through the prejudiced eyes of his friend Von Buch. "Over your and Charpentier's moraines," he says, in one of his letters, "Leopold von Buch rages, as you may already know, considering the subject, as he does, his exclusive property. But I too, though by no means so bitterly opposed to new views, and ready to believe that the boulders have not all been moved by the same means, am yet inclined to think the moraines due to more local causes."

The next letter shows that Humboldt was seriously anxious lest this new field of activ-

ity, with its fascinating speculations, should draw Agassiz away from his ichthyological researches.

HUMBOLDT TO AGASSIZ.

BERLIN, *December* 2, 1837.

I have this moment received, my dear friend, by the hand of M. de Werther, the cabinet minister, your eighth and ninth numbers, with a fine pamphlet of text. I hasten to express my warm thanks, and I congratulate the public on your somewhat tardy resolution to give a larger proportion of text. One should flatter neither the king, nor the people, nor one's dearest friend. I maintain, therefore, that no one has told you forcibly enough how the very persons who justly admire your work, constantly complain of this fragmentary style of publication, which is the despair of those who have not the leisure to place your scattered sheets where they belong and disentangle the skein.[1]

I think you would do well to publish for a while more text than plates. You could do

[1] Owing to the irregularity with which he received and was forced to work up his material, Agassiz was often either in advance or in arrears with certain parts of his subject, so that his plates and his text did not keep pace with each other, thus causing his readers much annoyance.

this the better because your text is excellent, full of new and important ideas, expressed with admirable clearness. The charming letter (again without a date) which preceded your package impressed me painfully. I see you are ill again; you complain of congestion of the head and eyes. For mercy's sake take care of your health which is so dear to us. I am afraid you work too much, and (shall I say it frankly?) that you spread your intellect over too many subjects at once. I think that you should concentrate your moral and also your pecuniary strength upon this beautiful work on fossil fishes. In so doing you will render a greater service to positive geology, than by these general considerations (a little icy withal) on the revolutions of the primitive world; considerations which, as you well know, convince only those who give them birth. In accepting considerable sums from England, you have, so to speak, contracted obligations to be met only by completing a work which will be at once a monument to your own glory and a landmark in the history of science. Admirable and exact as your researches on other fossils are, your contemporaries claim from you the fishes above all. You will say that this is making you the slave

of others; perfectly true, but such is the pleasing position of affairs here below. Have I not been driven for thirty-three years to busy myself with that tiresome America, and am I not, even yet, daily insulted because, after publishing thirty-two volumes of the great edition in folio and in quarto, and twelve hundred plates, one volume of the historical section is wanting? We men of letters are the servants of an arbitrary master, whom we have imprudently chosen, who flatters and pets us first, and then tyrannizes over us if we do not work to his liking. You see, my dear friend, I play the grumbling old man, and, at the risk of deeply displeasing you, place myself on the side of the despotic public. . . .

With reference to the general or periodical lowering of the temperature of the globe, I have never thought it necessary, on account of the elephant of the Lena, to admit that sudden frost of which Cuvier used to speak. What I have seen in Siberia, and what has been observed in Captain Beechey's expedition on the northwest coast of America, simply proves that there exists a layer of frozen drift, in the fissures of which (even now) the muscular flesh of any animal which should accidentally fall into them would be preserved intact.

It is a slight local phenomenon. To me, the ensemble of geological phenomena seems to prove, not the prevalence of this glacial surface on which you would carry along your boulders, but a very high temperature spreading almost to the poles, a temperature favorable to organizations resembling those now living in the tropics. Your ice frightens me, and gladly as I would welcome you here, my dear friend, I think, perhaps, for the sake of your health, and also that you may not see this country, always so hideous, under a sheet of snow and ice (in February), you would do better to come two months later, with the first verdure. This is suggested by a letter received yesterday by M. d'O——, which alarmed me a little, because the state of your eyes obliged you to write by another hand. Pray do not think of traveling before you are quite well. I close this letter, feeling sure that it does not contain a line which is not an expression of friendship and of the high esteem I bear you. The magnificence of your last numbers, eight and nine, cannot be told. How admirably executed are your Macropoma, the Ophiopris procerus, Mantell's great beast, the minute details of the Dercetis, Psammodus, . . . the skeletons. . . . There is nothing

like it in all that we possess upon vertebrates. I have also begun to study your text, so rich in well arranged facts; the monograph of the Lepidostei, the passage upon the bony rays, and, dear Agassiz, I could hardly believe my eyes, sixty-five continuous pages of the third volume, without interruption! You will spoil the public. But, my good friend, you have already information upon a thousand species; "claudite jam rivos!" You say your work can go on if you have two hundred subscribers; but if you continue to support two traveling draughtsmen, I predict, as a practical man, that it cannot go on. You cannot even publish what you have gathered in the last five years. Consider that in attempting to give a review of all the fossil fishes which now exist in collections, you pursue a phantom which ever flies before you. Such a work would not be finished in less than fifteen years, and besides, this *now* is an uncertain element. Cannot you conquer yourself so far as to finish what you have in your possession at present? Recall your artists. With the reputation you enjoy in Europe, whatever might essentially change your opinion on certain organisms would willingly be sent to you. If you continue to keep two ambassadors in for-

eign lands, the means you destine for the engraving and printing will soon be absorbed. You will struggle with domestic difficulties, and at sixty years of age (tremble at the sight of this number!) you will be as uncertain as you are to-day, whether you possess, even in your collection of drawings, all that is to be found among amateurs. How exhaust an ocean in which the species are indefinitely increasing? Finish, first, what you have this December, 1837, and then, if the subject does not weary you, publish the supplements in 1847. You must not forget that these supplements will be of two kinds: 1st. Ideas which modify some of your old views. 2d. New species. Only the first kind of supplement would be really desirable. Furthermore, you must regain your intellectual independence and not let yourself be scolded any more by M. de Humboldt. Little will it avail you should I vanish from the scene of this world with your fourteenth number! When I am a fossil in my turn I shall still appear to you as a ghost, having under my arm the pages you have failed to interpolate and the volume of that eternal America which I owe to the public. I close with a touch of fun, in order that my letter may seem a little less

like preaching. A thousand affectionate remembrances. No more ice, not much of echinoderms, plenty of fish, recall of ambassadors *in partibus*, and great severity toward the book-sellers, an infernal race, two or three of whom have been killed under me.

A. DE HUMBOLDT.

I sigh to think of the trouble my horrible writing will give you.

A letter of about the same date from Von Buch shows that, however he might storm at Agassiz's heterodox geology, he was in full sympathy with his work in general.

LEOPOLD VON BUCH TO LOUIS AGASSIZ.

December 22, 1837.

. . . Pray reinstate me in the good graces of my unknown benefactor among you. By a great mistake the reports of the Society forwarded to me from Neuchâtel have been sent back. As it is well known at the post-office that I do not keep the piles of educational journals sent to me from France, the postage on them being much too heavy for my means, they took it for granted that this journal, the charges on which amounted to several crowns, was of the number. I am very sorry. I do

not even know the contents of the journal, but I suppose it contained papers of yours, full of genius and ardor. I like your way of looking at nature, and I think you render great service to science by your observations. A right spirit will readily lead you to see that this is the true road to glory, far preferable to the one which leads to vain analogies and speculations, the time for which is long past. I am grieved to hear that you are not well, and that your eyes refuse their service. M. de Humboldt tells me that you are seeking a better climate here, in the month of February. You may find it, perhaps, thanks to our stoves. But as we shall still have plenty of ice in the streets, your glacial opinions will not find a market at that season. I should like to present you with a memoir or monograph of mine, just published, on Spirifer and Orthis, but I will take good care to let no one pay postage on a work which, by its nature, can have but a very limited interest. . . . I will await your arrival to give you these descriptions. I am expecting the numbers of your Fossil Fishes, which have not yet come. Humboldt often speaks of them to me. Ah! how much I prefer you in a field which is wholly your own than in one where you break in

upon the measured and cautious tread, introduced by Saussure in geology. You, too, will reconsider all this, and will yet treat the views of Saussure and Escher with more respect. Everything here turns to infusoria. Ehrenberg has just discovered that an apparently sandy deposit, twenty feet in thickness, under the "Luneburgerheyde," is composed entirely of infusoria of a kind still living in the neighborhood of Berlin. This layer rests upon a brown deposit known to be ten feet in thickness. The latter consists, for one fifth of the depth, of pine pollen, which burns. The rest is of infusoria. Thus these animals, which the naked eye has not power to discern, have themselves the power to build up mountain chains. . . .

CHAPTER IX.

1837–1839: ÆT. 30–32.

Invitation to Professorships at Geneva and Lausanne. — Death of his Father. — Establishment of Lithographic Press at Neuchâtel. — Researches upon Structure of Mollusks. — Internal Casts of Shells. — Glacial Explorations. — Views of Buckland. — Relations with Arnold Guyot. — Their Work together in the Alps. — Letter to Sir Philip Egerton concerning Glacial Work. — Summer of 1839. — Publication of "Etudes sur les Glaciers."

ALTHOUGH Agassiz's daring treatment of the glacial phenomena had excited much opposition and angry comment, it had also made a powerful impression by its eloquence and originality. To this may be partly due the fact that about this time he was strongly urged from various quarters to leave Neuchâtel for some larger field. One of the most seductive of these invitations, owing to the affectionate spirit in which it was offered, came through Monsieur de la Rive, in Geneva.

M. AUGUSTE DE LA RIVE TO LOUIS AGASSIZ.

GENEVA, *May* 12, 1836.

. . . I have not yet received your address. I hope you will send it to me without delay, for I am anxious to bring it before our readers. I hope also that you will not forget what you have promised me for the "Bibliothèque Universelle." I am exceedingly anxious to have your coöperation; the more so that it will reinforce that of several distinguished savants whose assistance I have recently secured.

If I weary you with a second letter, however, it is not only to remind you of your promise about the "Bibliothèque Universelle," but for another object still more important and urgent. The matter stands thus. Our academic courses have just opened under favorable auspices. The number of students is much increased, and, especially, we have a good many from Germany and England. This circumstance makes us feel more strongly the importance of completing our organization, and of doing this wisely and quickly. I will not play the diplomat with you, but will frankly say, without circumlocution, that you seem to me the one essential, the one indis-

pensable man. After having talked with some influential persons here, I feel sure that if you say to me, "I will come," I can obtain for you the following conditions: 1st. A regular salary of three thousand francs, beside the student fees, which, in view of the character of your instruction, your reputation, and the novelty of your course, I place too low at a thousand francs; of this I am convinced. 2d. The vacant professorship is one of geology and mineralogy, but should you wish it De la Planche will continue to teach the mineralogy, and you will replace it by paleontology, or any other subject which may suit you. . . . Add to this resource that of a popular course for the world outside, ladies and others, which you might give in the winter, as at Neuchâtel. The custom here is to pay fifty francs for the course of from twenty-five to thirty lectures. You will easily see that for such a course you would have at least as large an audience here as at Neuchâtel. This is the more likely because there is a demand for these courses, Pictet being dead, and M. Rossi and M. de Castella having ceased to give them. No one has come forward as their heir, fine as the inheritance is; some are too busy, others have not the kind of talent

needed, and none have attempted to replace these gentlemen in this especial line, one in which you excel, both by your gifts and your fortunate choice of a subject more in vogue just now than any other. Come then, to work in this rich vein before others present themselves for the same purpose. Finally, since I must make up your budget, the "Bibliothèque Universelle," which pays fifty francs a sheet, would be always open to you; there you could bring the fruits of your productive leisure. Certainly it would be easy for you to make in this way an additional thousand francs.

Here, then, is a statement, precise and full, of the condition of things, and of what you may hope to find here. The moment is propitious; there is a movement among us just now in favor of the sciences, and this winter the plan of a large building for our museum and library will be presented to our common council. The work should begin next summer; you well know how much we should value your ideas and your advice on this subject. There may also be question of a director for the museum, and of an apartment for him in the new edifice; you will not doubt to whom such a place would be offered. But let

us not draw upon the future; let us limit ourselves to the present, and see whether what I propose suits you. . . . Come! let yourself be persuaded. Sacrifice the capital to a provincial town. At Berlin, no doubt, you would be happy and honored; at Geneva, you would be the happiest, the most honored. Look at ——, who shone as a star of the first magnitude at Geneva, and who is but a star of second or third rank in Paris. This, to be sure, would not be your case; nevertheless, I am satisfied that at Geneva, where you would be a second de Saussure, your position would be still more brilliant. I know that these motives of scientific self-love have little weight with you; nevertheless, wishing to omit nothing, I give them for what they are worth. But my hope rests far more on the arguments I have first presented; they come from the heart, and with you the heart responds as readily as the genius. But enough! I will not fatigue you with farther considerations. I think I have given you all the points necessary for your decision. Be so kind as to let me know as soon as possible what you intend to do. Have the kindness also not to speak of the contents of this letter, and remember that it is not the Rector of the Academy of Geneva, but the

Professor Auguste de la Rive, who writes in his own private person. Promptitude and silence, then, are the two recommendations which I make to you while we await the *Yes* we so greatly desire. . . .

More tempting still must have been the official invitation received a few months later to a professorship at Lausanne, strengthened as it was by the affectionate entreaties of relations and friends, urging him for the sake of family ties and patriotism to return to the canton where he had passed his earlier years. But he had cast in his lot with the Neuchâtelois and was proof against all arguments. He remained faithful to the post he had chosen until he left it, temporarily as he then believed, to come to America. The citizens of his adopted town expressed their appreciation of his loyalty to them in a warm letter of thanks, begging, at the same time, his acceptance of the sum of six thousand francs, payable by installments during three years.

The summer of 1837 was a sad one to Agassiz and to his whole family; his father died at Concise, carried off by a fever while still a comparatively young man. The pretty parsonage, to which they were so much at-

tached, passed into other hands, and thenceforward the home of Madame Agassiz was with her children, among whom she divided her time.

In 1838 Agassiz founded a lithographic printing establishment in Neuchâtel, which was carried on for many years under his direction. Thus far his plates had been lithographed in Munich. Their execution at such a distance involved constant annoyance, and sometimes great waste of time and money, in sending the proofs to and fro for correction. The scheme of establishing a lithographic press, to be in a great degree at his charge, was certainly an imprudent one for a poor man; but Agassiz hoped not only to facilitate his own publications by this means, but also to raise the standard of execution in works of a purely scientific character. Supported partly by his own exertions, partly by the generosity of others, the establishment was almost exclusively dependent upon him for its unceasing activity. He was fortunate in securing for its head M. Hercule Nicolet, a very able lithographic artist, who had had much experience in engraving objects of natural history, and was specially versed in the recently invented art of chromatic lithography.

Agassiz was now driving all his steeds abreast. Beside his duties as professor, he was printing at the same time his "Fossil Fishes," his "Fresh-Water Fishes," and his investigations on fossil Echinoderms and Mollusks, — the illustrations for all these various works being under his daily supervision. The execution of these plates, under M. Nicolet's care, was admirable for the period. Professor Arnold Guyot, in his memoir of Agassiz, says of the plates for the "Fresh-Water Fishes": "We wonder at their beauty, and at their perfection of color and outline, when we remember that they were almost the first essays of the newly-invented art of lithochromy, produced at a time when France and Belgium were showering rewards on very inferior work of the kind, as the foremost specimens of progress in the art."

All this work could hardly be carried on single handed. In 1837 M. Edouard Desor joined Agassiz in Neuchâtel, and became for many years his intimate associate in scientific labors. A year or two later M. Charles Vogt also united himself to the band of investigators and artists who had clustered about Agassiz as their central force. M. Ernest Favre says of this period of his life: "He displayed

during these years an incredible energy, of which the history of science offers, perhaps, no other example."

Among his most important zoölogical researches at this time were those upon mollusks. His method of studying this class was too original and too characteristic to be passed by without notice The science of conchology had heretofore been based almost wholly upon the study of the empty shells. To Agassiz this seemed superficial. Longing to know more of the relation between the animal and its outer covering, he bethought himself that the inner moulding of the shell would give at least the form of its old inhabitant. For the practical work he engaged an admirable moulder, M. Stahl, who continued to be one of his staff at the lithographic establishment until he became permanently employed at the Jardin des Plantes. With his help and that of M. Henri Ladame, professor of physics and chemistry at Neuchâtel, who prepared the delicate metal alloys in which the first mould was taken, Agassiz obtained casts in which the form of the animals belonging to the shells was perfectly reproduced. This method has since passed into universal use. By its aid he obtained a new means of ascertaining the re-

lations between fossil and living mollusks. It was of vast service to him in preparing his "Etudes critiques sur les Mollusques fossiles," — a quarto volume with nearly one hundred plates.

The following letter to Sir Philip Egerton gives some account of his undertakings at this time, and of the difficulties entailed upon him by their number and variety.

LOUIS AGASSIZ TO SIR PHILIP EGERTON.

NEUCHÂTEL, *August* 10, 1838.

. . . These last months have been a time of trial to me, and I have been forced to give up my correspondence completely in order to meet the ever-increasing demands of my work. You know how difficult it is to find a quiet moment and an easy mind for writing, when one is pursued by printing or lithographic proofs, and forced besides to prepare unceasing occupation for numerous employés. Add to this the close research required by the work of editing, and you surely will find an excuse for my delay. I think I have already written you that in order to have everything under my own eye, I had founded a lithographic establishment at Neuchâtel in the hope of avoiding in future the procrastinations to which

my proofs were liable when the work was done at Munich. . . . I hope that my new publications will be sufficiently well received to justify me in supporting an establishment unique of its kind, which I have founded solely in the interest of science and at the risk of my peace and my health. If I give you all these details, it is simply to explain my silence, which was caused not by pure negligence, but by the demands of an undertaking in the success of which my very existence is involved. . . . This week I shall forward to the Secretary of the British Association for the Advancement of Science all that I have been able to do thus far, being unable to bring it myself, as I had hoped. You would oblige me greatly if you would give a look at these different works, which may, I hope, have various claims on your interest. First, there is the tenth number of the "Fossil Fishes," though the whole supply of publisher's copies will only be sent a few weeks later. Then there are the seven first plates of my sea-urchins, engraved with much care and with many details. A third series of plates relates to critical studies on fossil mollusks, little or erroneously known, and on their internal casts. This is a quite novel side of the study of shells, and

will throw light on the organization of animals known hitherto only by the shell. I have made a plaster collection of them for the Geological Society. They have been packed some time, but my late journey to Paris has prevented me from forwarding them till now. As soon as I have a moment, I shall make out the catalogue and send it on. When you go to London, do not fail to examine them; the result is curious enough. Finally, the plates for the first number of my "Fresh-Water Fishes" are in great part finished, and also included in my package for Newcastle. . . . The plates are executed by a new process, and printed in various tints on different stones, resulting in a remarkable uniformity of coloring in all the impressions. . . .

Such are the new credentials with which I present myself, as I bring my thanks for the honor paid to me by my nomination for the vacancy in the Royal Society of London. If unbounded devotion to the interests of science constituted a sufficient title to such a distinction, I should be the less surprised at the announcement contained in your last letter. The action of the Royal Society, so flattering to the candidate of your choice, has satisfied a desire which I should hardly have dared to

form for many a year, — that of becoming a member of a body so illustrious as the Royal Society of London. . . .

Each time I write I wish I could close with the hope of seeing you soon; but I must work incessantly; that is my lot, and the happiness I find in it gives a charm to my occupations however numerous they may be. . . .

While Agassiz's various zoölogical works were thus pressed with unceasing activity, the glaciers and their attendant phenomena, which had so captivated his imagination, were ever present to his thought. In August of the year 1838, a year after he had announced at the meeting of the Helvetic Society his comprehensive theory respecting the action of ice over the whole northern hemisphere, he made two important excursions in the Alps. The first was to the valley of Hassli, the second to the glaciers of Mont Blanc. In both he was accompanied by his scientific collaborator, M. Desor, whose intrepidity and ardor hardly fell short of his own; by Mr. Dinkel as artist, and by one or two students and friends. These excursions were a kind of prelude to his more prolonged sojourns on the Alps, and to the series of observations car-

ried on by him and his companions, which attracted so much attention in later years. But though Agassiz carried with him, on these first explorations, only the simplest means of investigation and experiment, they were no amateur excursions. On these first Alpine journeys he had in his mind the sketch he meant to fill out. The significance of the phenomena was already clear to him. What he sought was the connection. Following the same comparative method, he intended to track the footsteps of the ice as he had gathered and put together the fragments of his fossil fishes, till the scattered facts should fall into their natural order once more and tell their story from beginning to end.

In his explorations of 1838 he found everywhere the same phenomena; the grooved and polished and graven surfaces and the rounded and modeled rocks, often lying far above and beyond the present limits of the glaciers; the old moraines, long deserted by the ice, but defining its ancient frontiers; the erratic blocks, transported far from their place of origin and disposed in an order and position unexplained by the agency of water.

These excursions, though not without their dangers and fatigues, were full of charm for

men who, however serious their aims, were still young enough to enter like boys into the spirit of adventure. Agassiz himself was but thirty-one; an ardent pedestrian, he delighted in feats of walking and climbing. His friend Dinkel relates that one day, while pausing at Grindelwald for refreshment, they met an elderly traveler who asked him, after listening awhile to their gay talk, in which appeals were constantly made to "Agassiz," if that was perhaps the son of the celebrated professor of Neuchâtel. The answer amazed him; he could hardly believe that the young man before him was the naturalist of European reputation. In connection with this journey occurs the first attempt at an English letter found among Agassiz's papers. It is addressed to Buckland, and contains this passage: "Since I saw the glaciers I am quite of a snowy humor, and will have the whole surface of the earth covered with ice, and the whole prior creation dead by cold. In fact, I am quite satisfied that ice must be taken [included] in every complete explanation of the last changes which occurred at the surface of Europe." Considered in connection with their subsequent work together in the ancient ice-beds and moraines of England, Scotland, Ireland,

and Wales, it is curious to find Buckland answering: "I am sorry that I cannot entirely adopt the new theory you advocate to explain transported blocks by moraines; for supposing it adequate to explain the phenomena of Switzerland, it would not apply to the granite blocks and transported gravel of England, which I can only explain by referring to currents of water." During the same summer Mrs. Buckland writes from Interlaken, in the course of a journey in Switzerland with her husband. . . . "We have made a good tour of the Oberland and have seen glaciers, etc., but Dr. Buckland is as far as ever from agreeing with you." We shall see hereafter how completely he became a convert to Agassiz's glacial theory in its widest acceptation.

One friend, scarcely mentioned thus far in this biography, was yet, from the beginning, the close associate of Agassiz's glacier work. Arnold Guyot and he had been friends from boyhood. Their university life separated them for a time, Guyot being at Berlin while Agassiz was at Munich, and they became colleagues at Neuchâtel only after Agassiz had been for some years established there. From that time forward there was hardly any break in their intercourse; they came to America at about

the same time, and finally settled as professors, the one at Harvard College, in Cambridge, Massachusetts, and the other at the College of New Jersey, in Princeton. They shared all their scientific interests; and when they were both old men, Guyot brought to Agassiz's final undertaking, the establishment of a summer school at Penikese, a coöperation as active and affectionate as that he had given in his youth to his friend's scheme for establishing a permanent scientific summer station in the high Alps.

In a short visit made by Agassiz to Paris in the spring of 1838 he unfolded his whole plan to Guyot, then residing there, and persuaded him to undertake a certain part of the investigation. During this very summer of 1838, therefore, while Agassiz was tracing the ancient limits of the ice in the Bernese Oberland and the Haut Valais, and later, in the valley of Chamounix, Guyot was studying the structure and movement of the ice during a six weeks' tour in the central Alps. At the conclusion of their respective journeys they met to compare notes, at the session of the Geological Society of France, at Porrentruy, where Agassiz made a report upon the general results of his summer's work; while Guyot

read a paper, the contents of which have never been fully published, upon the movement of glaciers and upon their internal features, including the laminated structure of the ice, the so-called blue bands, deep down in the mass of the glacier.[1] In the succeeding years of their glacial researches together, Guyot took for his share the more special geological problems, the distribution of erratic boulders and of the glacial drift, as connected with the ancient extension of the glaciers. This led him away from the central station of observation to remoter valleys on the northern and southern slopes of the Alps, where he followed the descent of the glacial phenomena to the plains of central Europe on the one side and to those of northern Italy on the other. We therefore seldom hear of him with the band of workers who finally settled on the glacier of the Aar, because his share of the undertaking became a more isolated one. It was nevertheless an integral part of the original scheme, which was carried on connectedly to the end, the results of the work in the different departments being constantly reported and compared. So much was this the case, that the intention of Agas-

[1] See *Memoir of Louis Agassiz*, by Arnold Guyot, written for the United States National Academy of Sciences, p. 38.

siz had been to embody the whole in a publication, the first part of which should contain the glacial system of Agassiz; the second the Alpine erratics, by Guyot; while the third and final portion, by E. Desor, should treat of the erratic phenomena outside of Switzerland. The first volume alone was completed. Unlooked for circumstances made the continuation of the work impossible, and the five thousand specimens of the erratic rocks of Switzerland collected by Professor Guyot, in preparation for his part of the publication, are now deposited in the College of New Jersey, at Princeton.

In the following summer of 1839 Agassiz took the chain of Monte Rosa and Matterhorn as the field of a larger and more systematic observation. On this occasion, the usual party consisting of Agassiz, Desor, M. Bettanier, an artist, and two or three other friends, was joined by the geologist Studer. Up to this time he had been a powerful opponent of Agassiz's views, and his conversion to the glacial theory during this excursion was looked upon by them all as a victory greater than any gained over the regions of ice and snow. Some account of this journey occurs in the following letter.

LOUIS AGASSIZ TO SIR PHILIP EGERTON.

NEUCHÂTEL, *September* 10, 1839.

. . . Under these circumstances, I thought I could not do better than to pass some weeks in the solitude of the high Alps; I lived about a fortnight in the region of the glaciers, ascending some new field of ice every day, and trying to scale the sides of our highest peaks. I thus examined in succession all the glaciers descending from the majestic summits of Monte Rosa and the Matterhorn, whose numerous crests form a most gigantic amphitheatre, which lifts itself above the everlasting snow. Afterward I visited the sea of ice which, under the name of the glacier of Aletsch, flows from the Jungfrau, the Mönch, and the Eiger toward Brieg; thence I went to the glacier of the Rhône, and from there, establishing my headquarters at the Hospice of the Grimsel, I followed the glacier of the Aar to the foot of the Finsteraarhorn. There I ascertained the most important fact that I now know concerning the advance of glaciers, namely, that the cabin constructed by Hugi in 1827, at the foot of the Abschwung, is now four thousand feet lower down. Slight as is the inclination of the glacier, this

cabin has been carried on by the ice with astonishing rapidity, and still more important is it that this rapidity has been on the increase; for in 1830 the cabin was only some hundred feet from the rock, in 1836 it had already passed over a distance from [word torn away] of two thousand feet, and in the last three years it has again doubled that distance. Not only have I confirmed my views upon glaciers and their attendant phenomena, on this new ground, but I have completed my examination of a number of details, and have had besides the satisfaction of convincing one of my most severe opponents of the exactness of my observations, namely, M. Studer, who accompanied me on a part of these excursions. . . .

The winter of 1840 was fully occupied by the preparation for the publication of the "Etudes sur les Glaciers," which appeared before the year was out, accompanied by an atlas of thirty-two plates. The volume of text consisted of an historical résumé of all that had previously been done in the study of glaciers, followed by an account of the observations of Agassiz and his companions during the last three or four years upon the glaciers of the Alps. Their structure, external aspect,

needles, tables, perched blocks, gravel cones, rifts, and crevasses, as well as their movements, mode of formation, and internal temperature, were treated in succession. But the most interesting chapters, from the author's own point of view, and those which were most novel for his readers, were the concluding ones upon the ancient extension of the Swiss glaciers, and upon the former existence of an immense, unbroken sheet of ice, which had once covered the whole northern hemisphere. No one before had drawn such vast conclusions from the local phenomena of the Alpine valleys. "The surface of Europe," says Agassiz, "adorned before by a tropical vegetation and inhabited by troops of large elephants, enormous hippopotami, and gigantic carnivora, was suddenly buried under a vast mantle of ice, covering alike plains, lakes, seas and plateaus. Upon the life and movement of a powerful creation fell the silence of death. Springs paused, rivers ceased to flow, the rays of the sun, rising upon this frozen shore (if, indeed, it was reached by them), were met only by the breath of the winter from the north and the thunders of the crevasses as they opened across the surface of this icy sea."[1] The author goes on to state that on

[1] *Études sur les Glaciers.* Chapter xviii. p. 315.

the breaking up of this universal shroud the ice must have lingered longest in mountainous strongholds, and that all these fastnesses of retreat became, as the Alps are now, centres of distribution for the broken débris and rocky fragments which are found scattered with a kind of regularity along certain lines, and over given areas in northern and central Europe. How he followed out this idea in his subsequent investigations will be seen hereafter.

CHAPTER X.

1840–1842 : ÆT. 33–35.

Summer Station on the Glacier of the Aar. — Hôtel des Neuchâtelois. — Members of the Party. — Work on the Glacier. — Ascent of the Strahleck and the Siedelhorn. — Visit to England. — Search for Glacial Remains in Great Britain. — Roads of Glen Roy. — Views of English Naturalists concerning Agassiz's Glacial Theory. — Letter from Humboldt. — Winter Visit to Glacier. — Summer of 1841 on the Glacier. — Descent into the Glacier. — Ascent of the Jungfrau.

In the summer of 1840 Agassiz made his first permanent station on the Alps. Hitherto the external phenomena, the relation of the ice to its surroundings, and its influence upon them, had been the chief study. Now the glacier itself was to be the main subject of investigation, and he took with him a variety of instruments for testing temperatures : barometers, thermometers, hygrometers, and psychometers ; beside a boring apparatus, by means of which self-registering thermometers might be lowered into the heart of the glacier. To these were added microscopes for the study of

such insects and plants as might be found in these ice-bound regions. The Hospice of the Grimsel was selected as his base of supplies, and as guides Jacob Leuthold and Johann Währen were chosen. Both of these had accompanied Hugi in his ascension of the Finsteraarhorn in 1828, and both were therefore thoroughly familiar with all the dangers of Alpine climbing. The lower Aar glacier was to be the scene of their continuous work, and the centre from which their ascents of the neighboring summits would be made. Here, on the great median moraine, stood a huge boulder of micaceous schist. Its upper surface projected so as to form a roof, and by closing it in on one side with a stone wall, leveling the floor by a judicious arrangement of flat slabs, and rigging a blanket in front to serve as a curtain across the entrance, the whole was presently transformed into a rude hut, where six persons could find sleeping-room. A recess, sheltered by the rock outside, served as kitchen and dining-room; while an empty space under another large boulder was utilized as a cellar for the keeping of provisions. This was the abode so well known afterward as the Hôtel des Neuchâtelois. Its first occupants were Louis Agassiz, Edouard

Desor, Charles Vogt, François de Pourtalès, Célestin Nicolet, and Henri Coulon. It afforded, perhaps, as good a shelter as they could have found in the old cabin of Hugi, where they had hoped to make their temporary home. In this they were disappointed, for the cabin had crumbled on its last glacial journey. The wreck was lying two hundred feet below the spot where they had seen the walls still standing the year before.

The work was at once distributed among the different members of the party, — Agassiz himself, assisted by his young friend and favorite pupil, François de Pourtalès, retaining for his own share the meteorological observations, and especially those upon the internal temperature of the glaciers.[1] To M. Vogt fell the microscopic study of the red snow and the organic life contained in it; to M. Nicolet, the flora of the glaciers and the surrounding rocks; to M. Desor, the glacial phenomena proper, including those of the moraines. He had the companionship and assist-

[1] See "Tables of Temperature, Measurements," etc., in Agassiz's *Système Glaciaire*. These results are also recorded in a volume entitled *Séjours dans les Glaciers*, by Edouard Desor, a collection of very bright and entertaining articles upon the excursions and sojourns made in the Alps, during successive summers, by Agassiz and his scientific staff.

ance of M. Henri Coulon in the long and laborious excursions required for this part of the work.

This is not the place for scientific details. For the results of Agassiz's researches on the Alpine glaciers, to which he devoted much of his time and energy during ten years, from 1836 to 1846, the reader is referred to his two larger works on this subject, the "Etudes sur les Glaciers," and the "Système Glaciaire." Of the work accomplished by him and his companions during these years this slight summary is given by his friend Guyot.[1] "The position of eighteen of the most prominent rocks on the glacier was determined by careful triangulation by a skillful engineer, and measured year after year to establish the rate of motion of every part. The differences in the rate of motion in the upper and lower part of the glacier, as well as in different seasons of the year, was ascertained; the amount of the annual melting was computed, and all the phenomena connected with it studied. All the surrounding peaks, — the Jungfrau, the Schreckhorn, the Finsteraarhorn, most of them

[1] See Biographical Sketch, published by Professor A. Guyot, under the auspices of the United States National Academy.

until then reputed unscalable, — were ascended, and the limit of glacial action discovered; in short all the physical laws of the glacier were brought to light."

We now return to the personal narrative. After a number of days spent in the study of the local phenomena, the band of workers turned their attention to the second part of their programme, namely, the ascent of the Strahleck, by crossing which and descending on the other side, they intended to reach Grindelwald. One morning, then, toward the end of August, their guides, according to agreement, aroused them at three o'clock, — an hour earlier than their usual roll-call. The first glance outside spread a general chill of disappointment over the party, for they found themselves beleaguered by a wall of fog on every side. But Leuthold, as he lighted the fire and prepared breakfast, bade them not despair, — the sun might make all right. In a few moments, one by one, the summits of the Schreckhorn, the Finsteraarhorn, the Oberaarhorn, the Altmaner, the Scheuchzerhorn, lighted by the first rays of the sun, came out like islands above the ocean of mist, which softly broke away and vanished with the advancing light. In about three hours they

reached the base of the Strahleck. Their two guides, Leuthold and Währen, had engaged three additional men for this excursion, so that they now had five guides, none of whom were superfluous, since they carried with them various barometric instruments which required careful handling. They began the ascent in single file, but the slopes soon became so steep and the light snow (in which they floundered to the knees at every step) so deep, that the guides resorted to the usual method in such cases of tying them all together. The two head guides alone, Leuthold and Währen, remained detached, clearing the snow in front of them, cutting steps in the ice, and giving warning, by cry and gesture, of any hidden danger in the path. At nine o'clock, after an hour's climbing, they stepped upon the small plateau, evenly covered with unbroken snow, formed by the summit of the Strahleck.

The day had proved magnificent. With a clear sky above them, they looked down upon the valley of Grindelwald at their feet, while around and below them gathered the Scheideck and the Faulhorn, the pyramidal outline of the Niesen, and the chain of the Stockhorn. In front lay the great masses of the Eiger and the Mönch, while to the southwest

the Jungfrau rose above the long chain of the Viescherhörner. The first pause of silent wonder and delight, while they released themselves from their cords and arranged their instruments, seems to have been succeeded by an outburst of spirits; for in the journal of the youngest of the party, François de Pourtalès, then a lad of seventeen, we read: "The guides began to wrestle and we to dance, when suddenly we saw a female chamois, followed by her young, ascending a neighboring slope, and presently four or five more stretched their necks over a rock, as if to see what was going on. Breathless the wrestlers and the dancers paused, fearing to disturb by the slightest movement creatures so shy of human approach. They drew nearer until within easy gunshot distance, and then galloping along the opposite ridge disappeared over the summit."

The party passed more than an hour on the top of the Strahleck, making observations and taking measurements. Then having rested and broken their fast with such provisions as they had brought, they prepared for a descent, which proved the more rapid, since much of it was a long slide. Tied together once more, they slid, wherever they found it possible to exchange the painful and difficult walking

HOTEL DES NEUCHATELOIS.

for this simpler process. "Once below these slopes of snow," says the journal of young de Pourtalès again, "rocks almost vertical, or narrow ledges covered with grass, served us as a road and brought us to the glacier of the Grindelwald. To reach the glacier itself we traversed a crevasse of great depth, and some twenty feet wide, on a bridge of ice, one or two feet in width, and broken toward the end, where we were obliged to spring across. Once on the glacier the rest was nothing. The race was to the fastest, and we were soon on the path of the tourists." Reaching the village of Grindelwald at three o'clock in the afternoon, they found it difficult to persuade the people at the inn that they had left the glacier of the Aar that morning. From Grindelwald they returned by the Scheideck to the Grimsel, visiting on their way the upper glacier of Grindelwald, the glacier of Schwartzwald, and that of Rosenlaui, in order to see how far these had advanced since their last visit to them. After a short rest at the Hospice of the Grimsel, Agassiz returned with two or three of his companions to their hut on the Aar glacier for the purpose of driving stakes into the holes previously bored in the ice. He hoped by means of these stakes to learn the follow-

ing year what had been the rate of movement of the glacier. The summer's work closed with the ascent of the Siedelhorn. In all these ascents, the utmost pains was taken to ascertain how far the action of the ice might be traced upon these mountain peaks and the limits determined at which the polished surfaces ceased, giving place to the rough, angular rock which had never been modeled by the ice.

Agassiz had hardly returned from the Alps when he started for England. He had long believed that the Highlands of Scotland, the hilly Lake Country of England, and the mountains of Wales and Ireland, would present the same phenomena as the valleys of the Alps. Dr. Buckland had offered to be his guide in this search after glacier tracks, as he had formerly been in the hunt after fossil fishes in Great Britain. When, therefore, the meeting of the British Association at Glasgow, at which they were both present, was over, they started together for the Highlands. In a lecture delivered by Agassiz, at his summer school at Penikese, a few months before his death, he recurred to this journey with the enthusiasm of a young man. Recalling the scientific isolation in which he then stood, op-

posed as he was to all the prominent geologists of the day, he said: "Among the older naturalists, only one stood by me. Dr. Buckland, Dean of Westminster, who had come to Switzerland at my urgent request for the express purpose of seeing my evidence, and who had been fully convinced of the ancient extension of ice there, consented to accompany me on my glacier hunt in Great Britain. We went first to the Highlands of Scotland, and it is one of the delightful recollections of my life that as we approached the castle of the Duke of Argyll, standing in a valley not unlike some of the Swiss valleys, I said to Buckland: 'Here we shall find our first traces of glaciers;' and, as the stage entered the valley, we actually drove over an ancient terminal moraine, which spanned the opening of the valley." In short, Agassiz found, as he had anticipated, that in the mountains of Scotland, Wales, and the north of England, the valleys were in many instances traversed by terminal moraines and bordered by lateral ones, as in Switzerland. Nor were any of the accompanying phenomena wanting. The characteristic traces left by the ice, as well known to him now as the track of the game to the hunter; the peculiar lines, furrows,

and grooves; the polished surfaces, the roches moutonnées; the rocks, whether hard or soft, cut to one level, as by a rigid instrument; the unstratified drift and the distribution of loose material in relation to the ancient glacier-beds, — all agreed with what he already knew of glacial action. He visited the famous "roads of Glen Roy" in the Grampian Hills, where so many geologists had broken a lance in defense of their theories of subsidence and upheaval, of ancient ocean-levels and sea-beaches, formed at a time when they believed Glen Roy and the adjoining valleys to have been so many fiords and estuaries. To Agassiz, these parallel terraces explained themselves as the shores of a glacial lake, held back in its bed for a time by neighboring glaciers descending from more sheltered valleys. The terraces marked the successively lower levels at which the water stood, as these barriers yielded, and allowed its gradual escape.[1] The glacial action in the whole neighborhood was such as to leave no doubt in the mind of

[1] For details, see a paper by Agassiz on "The Glacial Theory and its Recent Progress" in the *Edinburgh New Philosophical Journal*, October, 1842, accompanied by a map of the Glen Roy region, and also an article entitled "Parallel Roads of Glen Roy, in Scotland," in the second volume of Agassiz's *Geological Sketches*.

Agassiz that Glen Roy and the adjoining glens, or valleys, had been the drainage-bed for the many glaciers formerly occupying the western ranges of the Grampian Hills. He returned from his tour satisfied that the mountainous districts of Great Britain had all been centres of glacial distribution, and that the drift material and the erratic boulders, scattered over the whole country, were due to exactly the same causes as the like phenomena in Switzerland. On the 4th of November, 1840, he read a paper before the Geological Society of London, giving a summary of the scientific results of their excursion, followed by one from Dr. Buckland, who had become an ardent convert to his views. Apropos of this meeting, Dr. Buckland writes in advance as follows: —

TAYMOUTH CASTLE, *October* 15, 1840.

. . . Lyell has adopted your theory *in toto*!!! On my showing him a beautiful cluster of moraines, within two miles of his father's house, he instantly accepted it, as solving a host of difficulties that have all his life embarrassed him. And not these only, but similar moraines and detritus of moraines, that cover half of the adjoining counties are

explicable on your theory, and he has consented to my proposal that he should immediately lay them all down on a map of the county and describe them in a paper to be read the day after yours at the Geological Society. I propose to give in my adhesion by reading, the same day with yours, as a sequel to your paper, a list of localities where I have observed similar glacial detritus in Scotland, since I left you, and in various parts of England.

There are great reefs of gravel in the limestone valleys of the central bog district of Ireland. They have a distinct name, which I forget. No doubt they are moraines; if you have not, ere you get this, seen one of them, pray do so.[1] But it will not be worth while to go out of your way to see more than one; all the rest must follow as a corollary. I trust you will not fail to be at Edinboro' on the 20th, and at Sir W. Trevelyan's on the 24th. . . .

A letter of later date in the same month

[1] Agassiz was then staying at Florence Court, the seat of the Earl of Enniskillen, in County Fermanagh, Ireland. While there he had an opportunity of studying most interesting glacial phenomena.

shows that Agassiz felt his views to be slowly gaining ground among his English friends.

LOUIS AGASSIZ TO SIR PHILIP EGERTON.

LONDON, *November* 24, 1840.

. . . Our meeting on Wednesday passed off very well; none of my facts were disturbed, though Whewell and Murchison attempted an opposition; but as their objections were far-fetched, they did not produce much effect. I was, however, delighted to have some appearance of serious opposition, because it gave me a chance to insist upon the exactness of my observations, and upon the want of solidity in the objections brought against them. Dr. Buckland was truly eloquent. He has now full possession of this subject; is, indeed, completely master of it.

I am happy to tell you that everything is definitely arranged with Lord Francis,[1] and that I now feel within myself a courage which doubles my strength. I have just written to thank him. To-morrow I shall devote to the fossils sent me by Lord Enniskillen, a list of which I will forward to you. . . .

[1] Apropos of the sale of his original drawings of fossil fishes to Lord Francis Egerton.

We append here, a little out of the regular course, a letter from Humboldt, which shows that he too was beginning to look more leniently upon Agassiz's glacial conclusions.

HUMBOLDT TO LOUIS AGASSIZ.

BERLIN, *August* 15, 1840.

I am the most guilty of mortals, my dear friend. There are not three persons in the world whose remembrance and affection I value more than yours, or for whom I have a warmer love and admiration, and yet I allow half the year to pass without giving you a sign of life, without any expression of my warm gratitude for the magnificent gifts I owe to you.[1]

I am a little like my republican friend who no longer answers any letters because he does not know where to begin. I receive on an average fifteen hundred letters a year. I never dictate. I hold that resort in horror. How dictate a letter to a scholar for whom one has a real regard? I allow myself to be drawn into answering the persons I know least, whose wrath is the most menacing. My nearer friends (and none are more dear to me

[1] Probably the plates of the *Fresh-Water Fishes* and other illustrated publications.

than yourself) suffer from my silence. I count with reason upon their indulgence. The tone of your excellent letters shows that I am right. You spoil me. Your letters continue to be always warm and affectionate. I receive few like them. Since two thirds of the letters addressed to me (partly copies of letters written to the king or the ministers) remain unanswered, I am blamed, charged with being a parvenu courtier, an apostate from science. This bitterness of individual claims does not diminish my ardent desire to be useful. I act oftener than I answer. I know that I like to do good, and this consciousness gives me tranquillity in spite of my over burdened life. You are happy, my dear Agassiz, in the more simple and yet truly proud position which you have created for yourself. You ought to take satisfaction in it as the father of a family, as an illustrious savant, as the originator and source of so many new ideas, of so many great and noble conceptions.

Your admirable work on the fossil fishes draws to a close. The last number, so rich in discoveries, and the prospectus, explaining the true state of this vast publication, have soothed all irritation regarding it. It is because I am so attached to you that I rejoice in the calmer

atmosphere you have thus established about you. The approaching completion of the fossil fishes delivers me also from the fear that a too great ardor might cause you irreparable losses. You have shown not only what a talent like yours can accomplish, but also how a noble courage can triumph over seemingly insurmountable obstacles.

In what words shall I tell you how greatly our admiration is increased by this new work of yours on the Fresh-Water Fishes? Nothing has appeared more admirable, more perfect in drawing and color. This chromatic lithography resembles nothing we have had thus far. What taste has directed the publication! Then the short descriptions accompanying each plate add singularly to the charm and the enjoyment of this kind of study. Accept my warm thanks, my dear friend. I not only delivered your letter and the copy with it to the king, but I added a short note on the merit of such an undertaking. The counselor of the Royal Cabinet writes me officially that the king has ordered the same number of copies of the Fresh-Water Fishes as of the Fossil Fishes; that is to say, ten copies. M. de Werther has already received the order. This is, to be sure, but a slight help; still,

it is all that I have been able to obtain, and these few copies, with the king's name as subscriber, will always be useful to you.

I cannot close this letter without asking your pardon for some expressions, too sharp, perhaps, in my former letters, about your vast geological conceptions. The very exaggeration of my expressions must have shown you how little weight I attached to my objections. . . . My desire is always to listen and to learn. Taught from my youth to believe that the organization of past times was somewhat tropical in character, and startled therefore at these glacial interruptions, I cried "Heresy!" at first. But should we not always listen to a friendly voice like yours? I am interested in whatever is printed on these topics; so, if you have published anything at all complete lately on the ensemble of your geological ideas, have the great kindness to send it to me through a book-seller. . . .

Shall I tell you anything of my own poor and superannuated works? The sixth volume is wanting to my "Geography of the Fifteenth Century" (Examen Critique). It will appear this summer. I am also printing the second volume of a new work to be entitled "Central Asia." It is not a second edition of "Asiatic

Fragments," but a new and wholly different work. The thirty-five sheets of the last volume are printed, but the two volumes will only be issued together. You can judge of the difficulty of printing at Paris and correcting proofs here, — at Poretz or at Töplitz. I am just now beginning to print the first number of my physics of the world, under the title of "Cosmos:" in German, "Ideen zur einer physischen Weltbeschreibung." It is in no sense a reproduction of the lectures I gave here. The subject is the same, but the presentation does not at all recall the form of a popular course. As a book, it has a somewhat graver and more elevated style. A "spoken book" is always a poor book, just as lectures read are poor however well prepared. Published courses of lectures are my detestation. Cotta is also printing a volume of mine in German, "Physikalische geographische Erinnerungen." Many unpublished things concerning the volcanoes of the Andes, about currents, etc. And all this at the age when one begins to petrify! It is very rash! May this letter prove to you and to Madame Agassiz that I am petrifying only at the extremities, — the heart is still warm. Retain for me the affection which I hold so dear.

A. DE HUMBOLDT.

In the following winter, or, rather, in the early days of March, 1841, Agassiz visited, in company with M. Desor, the glacier of the Aar and that of Rosenlaui. He wished to examine the stakes planted the summer before on the glacier of the Aar, and to compare the winter and summer temperature within as well as without the mass of ice. But his chief object was to ascertain whether water still flowed from beneath the glaciers during the frosts of winter. This fact would have a direct bearing upon the theory which referred the melting and movement of the glaciers chiefly to their lower surface, explaining them by the central heat of the earth as their main cause. Satisfied as he was of the fallacy of this notion, Agassiz still wished to have the evidence of the glacier itself. The journey was, of course, a difficult one at such a season, but the weather was beautiful, and they accomplished it in safety, though not without much suffering. They found no water except the pure and limpid water from springs that never freeze. The glacier lay dead in the grasp of winter. The results of this journey, tables of temperature, etc., are recorded in the "Système Glaciaire."

In E. Desor's "Séjours dans les Glaciers"

is found an interesting description of the incidents of this excursion and the appearance of the glaciers in winter. In ascending the course of the Aar they frequently crossed the shrunken river on natural snow bridges, and approaching the Handeck over fearfully steep slopes of snow they had some difficulty in finding the thread of water which was all that remained of the beautiful summer cascade. On the glacier of the Aar they found the Hôtel des Neuchâtelois buried in snow, while the whole surface of the glacier as well as the surrounding peaks, from base to summit, wore the same spotless mantle. The Finsteraarhorn alone stood out in bold relief, black against a white world, its abrupt slopes affording no foothold for the snow. The scene was far more monotonous than in summer. Crevasses, with their blue depths of ice, were closed; the many-voiced streams were still; the moraines and boulders were only here and there visible through the universal shroud. The sky was without a cloud, the air transparent, but the glitter of the uniform white surface was exquisitely painful to the eyes and skin, and the travelers were obliged to wrap their heads in double veils. They found the glacier of Rosenlaui less enveloped in

snow than that of the Aar; and though the magnificent ice-cave, so well known to travelers for its azure tints, was inaccessible, they could look into the vault and see that the habitual bed of the torrent was dry. The journey was accomplished in a week without any untoward accident.

In the summer of 1841 Agassiz made a longer Alpine sojourn than ever before. The special objects of the season's work were the internal structure of these vast moving fields of ice, the essential conditions of their origin and continued existence, the action of water within them as influencing their movement, and their own agency in direct contact with the beds and walls of the valleys they occupied. The fact of their former extension and their present oscillations might be considered as established. It remained to explain these facts with reference to the conditions prevailing within the mass itself. In short, the investigation was passing from the domain of geology to that of physics. Agassiz, who was as he often said of himself no physicist, was the more anxious to have the coöperation of the ablest men in that department, and to share with them such facilities for observation and such results as he had thus far accumu-

lated. In addition to his usual collaborators, M. Desor and M. Vogt, he had, therefore, invited as his guest, during part of the season, the distinguished physicist, Professor James D. Forbes, of Edinburgh, who brought with him his friend, Mr. Heath, of Cambridge.[1] M. Escher de la Linth took also an active part in the work of the later summer. To his working corps Agassiz had added the foreman of M. Kahli, an engineer at Bienne, to whom he had confided his plans for the summer, and who furnished him with a skilled workman to direct the boring operations, assist in measurements, etc. The artist of this year was M. Jaques Burkhardt, a personal friend of Agassiz, and his fellow-student at Munich, where he had spent some time at the school of art. As a draughtsman he was subsequently associated with Agassiz in his work at various times, and when they both settled in America Mr. Burkhardt became a permanent member of Agassiz's household, accompanied him on his journeys, and remained with him in relations of uninterrupted and affectionate regard till his own death in 1867. He was a loyal friend

[1] As the impressions of Mr. Forbes were only made known in connection with his own later and independent researches it is unnecessary to refer to them here.

and a warm-hearted man, with a thread of humor running through his dry good sense, which made him a very amusing and attractive companion.

As it was necessary, in view of his special programme of work, to penetrate below the surface of the glacier, and reach, if possible, its point of contact with the valley bottom, Agassiz had caused a larger boring apparatus than had been used before, to be transported to the old site on the Aar glacier. The results of these experiments are incorporated in the "Système Glaciaire," published in 1846, with twenty-four folio plates and two maps. They were of the highest interest with reference to the internal structure and temperature of the ice and the penetrability of its mass, pervious throughout, as it proved, to air and water. On one occasion the boring-rod, having been driven to a depth of one hundred and ten feet, dropped suddenly two feet lower, showing that it had passed through an open space hidden in the depth of the ice. The release of air-bubbles at the same time gave evidence that this glacial cave, so suddenly broken in upon, was not hermetically sealed to atmospheric influences from without.

Agassiz was not satisfied with the report of his instruments from these unknown regions. He determined to be lowered into one of the so-called wells in the glacier, and thus to visit its interior in person. For this purpose he was obliged to turn aside the stream which flowed into the well into a new bed which he caused to be dug for it. This done, he had a strong tripod erected over the opening, and, seated upon a board firmly attached by ropes, he was then let down into the well, his friend Escher lying flat on the edge of the precipice, to direct the descent and listen for any warning cry. Agassiz especially desired to ascertain how far the laminated or ribboned structure of the ice (the so-called blue bands) penetrated the mass of the glacier. This feature of the glacier had been observed and described by M. Guyot (see p. 292), but Mr. Forbes had called especial attention to it, as in his belief connected with the internal conditions of the glacier. It was agreed, as Agassiz bade farewell to his friends on this curious voyage of discovery, that he should be allowed to descend until he called out that they were to lift him. He was lowered successfully and without accident to a depth of eighty feet. There he encountered

an unforeseen difficulty in a wall of ice which divided the well into two compartments. He tried first the larger one, but finding it split again into several narrow tunnels, he caused himself to be raised sufficiently to enter the smaller, and again proceeded on his downward course without meeting any obstacle. Wholly engrossed in watching the blue bands, still visible in the glittering walls of ice, he was only aroused to the presence of approaching danger by the sudden plunge of his feet into water. His first shout of distress was misunderstood, and his friends lowered him into the ice-cold gulf instead of raising him. The second cry was effectual, and he was drawn up, though not without great difficulty, from a depth of one hundred and twenty-five feet. The most serious peril of the ascent was caused by the huge stalactites of ice, between the points of which he had to steer his way. Any one of them, if detached by the friction of the rope, might have caused his death. He afterward said: "Had I known all its dangers, perhaps I should not have started on such an adventure. Certainly, unless induced by some powerful scientific motive, I should not advise any one to follow my example." On this perilous journey he traced the laminated structure

to a depth of eighty feet, and even beyond, though with less distinctness.

The summer closed with their famous ascent of the Jungfrau. The party consisted of twelve persons: Agassiz, Desor, Forbes, Heath, and two travelers who had begged to join them, — M. de Chatelier, of Nantes, and M. de Pury, of Neuchâtel, a former pupil of Agassiz. The other six were guides; four beside their old and tried friends, Jacob Leuthold and Johann Währen. They left the hospice of the Grimsel on the 27th of August, at four o'clock in the morning. Crossing the Col of the Oberaar they descended to the snowy plateau which feeds the Viescher glacier. In this grand amphitheatre, walled in by the peaks of the Viescherhörner, they rested for their midday meal. In crossing these fields of snow, while walking with perfect security upon what seemed a solid mass, they observed certain window-like openings in the snow. Stooping to examine one of them, they looked into an immense open space, filled with soft blue light. They were, in fact, walking on a hollow crust, and the small window was, as they afterward found, opposite a large crevasse on the other side of this ice-cavern, through which the light entered, flood-

ing the whole vault and receiving from its icy walls its exquisite reflected color.[1]

Once across the fields of snow and névé, a fatiguing walk of five hours brought them to the chalets of Méril,[2] where they expected to sleep. The night which should have prepared them for the fatigue of the next day was, however, disturbed by an untoward accident. The ladder left by Jacob Leuthold when last here with Hugi in 1832, nine years before, and upon which he depended, had been taken away by a peasant of Viesch. Two messengers were sent in the course of the night to the village to demand its restoration. The first returned unsuccessful; the second was the bearer of such threats of summary punishment from the whole party that he carried his point, and appeared at last with the recovered treasure on his back. They had, in the mean while, lost two hours. They should have been on their road at three o'clock; it was now five. Jacob warned them therefore that they must make all speed, and that any one who felt himself unequal to a forced

[1] The effect is admirably described by M. Desor in his account of this excursion, *Séjours dans les Glaciers*, p. 367.

[2] Sometimes Möril, but I have retained the spelling of M. Desor. — E. C. A.

march should stay behind. No one responded to his suggestion, and they were presently on the road.

Passing Lake Méril, with its miniature icebergs, they reached the glacier of the Aletsch and its snow-fields, where the real difficulties and dangers of the ascent were to begin. In this great semicircular space, inclosed by the Jungfrau, the Mönch, and the lesser peaks of this mountain group, lies the Aletsch reservoir of snow or névé. As this spot presented a natural pause between the laborious ascent already accomplished and the immense declivities which lay before them yet to be climbed, they named it Le Repos, and halted there for a short rest. Here they left also every needless incumbrance, taking only a little bread and wine, in case of exhaustion, some meteorological instruments, and the inevitable ladder, axe, and ropes of the Alpine climber. On their left, to the west of the amphitheatre, a vast passage opened between the Jungfrau and the Kranzberg, and in this could be distinguished a series of terraces, one above the other. The story is the usual one, of more or less steep slopes, where they sank in the softer snow or cut their steps in the icy surfaces; of open crevasses, crossed by the lad-

der, or the more dangerous ones, masked by snow, over which they trod cautiously, tied together by the rope. But there was nothing to appall the experienced mountaineer with firm foot and a steady head, until they reached a height where the summit of the Jungfrau detached itself in apparently inaccessible isolation from all beneath or around it. To all but the guides their farther advance seemed blocked by a chaos of precipices, either of snow and ice or of rock. Leuthold remained however quietly confident, telling them he clearly saw the course he meant to follow. It began by an open gulf of unknown depth, though not too wide to be spanned by their ladder twenty-three feet in length. On the other side of this crevasse, and immediately above it, rose an abrupt wall of icy snow. Up this wall Leuthold and another guide led the way, cutting steps as they went. When half way up they lowered the rope, holding one end, while their companions fastened the other to the ladder, so that it served them as a kind of hand-rail, by which to follow. At the top they found themselves on a terrace, beyond which a far more moderate slope led to the Col of Roththal, overlooking the Aletsch valley on one side, the Roththal on the other.

From this point the ascent was more and more steep and very slow, as every step had to be cut. Their difficulties were increased, also, by a mist which gathered around them, and by the intense cold. Leuthold kept the party near the border of the ridge, because there the ice yielded more readily to the stroke of the axe; but it put their steadiness of nerve to the greatest test, by keeping the precipice constantly in view, except when hidden by the fog. Indeed, they could drive their alpenstocks through the overhanging rim of frozen snow, and look sheer down through the hole thus made to the amphitheatre below. One of the guides left them, unable longer to endure the sight of these precipices so close at hand. As they neared their goal they feared lest the mist might, at the last, deprive them of the culminating moment for which they had braved such dangers. But suddenly, as if touched by their perseverance, says M. Desor, the veil of fog lifted, and the summit of the Jungfrau, in its final solitude, rose before them. There was still a certain distance to be passed before they actually reached the base of the extreme peak. Here they paused, not without a certain hesitation, for though the summit lay but a few feet

PORTRAIT OF JACOB LEÜTHOLD.

From a portrait by J. Burkhardt.

above them, they were separated from it by a sharp and seemingly inaccessible ridge. Even Agassiz, who was not easily discouraged, said, as he looked up at this highest point of the fortress they had scaled: "We can never reach it." For all answer, Jacob Leuthold, their intrepid guide, flinging down everything which could embarrass his movements, stretched his alpenstock over the ridge as a grappling pole, and, trampling the snow as he went, so as to flatten his giddy path for those who were to follow, was in a moment on the top. To so steep an apex does this famous peak narrow, that but one person can stand on the summit at a time, nor was even this possible till the snow was beaten down. Returning on his steps, Leuthold, whose quiet, unflinching audacity of success was contagious, assisted each one to stand for a few moments where he had stood. The fog, the effect of which they had so much feared, now lent something to the beauty of the view from this sublime foothold. Masses of vapor rolled up from the Roththal on the southwest, but, instead of advancing to envelop them, paused at a little distance arrested by some current from the plain. The temperature being below freezing point, the drops of moisture in

this wall of vapor were congealed into ice-crystals, which glittered like gold in the sunlight and gave back all the colors of the rainbow.

When all the party were once more assembled at the base of the peak, Jacob, whose resources never failed, served to each one a little wine, and they rested on the snow before beginning their perilous descent. Of living things they saw only a hawk, poised in the air above their heads; of plants, a few lichens, where the surface of the rock was exposed. It was four o'clock in the afternoon before they started on their downward path, turning their faces to the icy slope, and feeling for the steps behind them, some seven hundred in all, which had been cut in ascending. In about an hour they reached the Col of the Roththal, where the greatest difficulties of the ascent had begun and the greatest dangers of the descent were over. So elated were they by the success of the day, and so regardless of lesser perils after those they had passed through, that they were now inclined to hurry forward incautiously. Jacob, prudent when others were rash, as he was bold when others were intimidated, constantly called them to order with his: "Hüb-

schle ! nur immer hübschle ! " (" Gently ! always gently ! ")

At six o'clock they were once more at Le Repos, having retraced their steps in two hours over a distance which had cost them six in going. Evening was now falling, but daylight was replaced by moonlight, and when they reached the glacier its whole surface shone with a soft silvery lustre, broken here and there by the gigantic shadow of some neighboring mountain thrown black across it. At about nine o'clock, just as they had passed that part of the glacier which was, on account of the frequent crevasses, the most dangerous, they were cheered by the sound of a distant jodel. It was the call of a peasant who had been charged to meet them with provisions, at a certain distance above Lake Méril, in case they should be overcome by hunger and fatigue. The most acceptable thing he brought was his great wooden bucket, filled with fresh milk. The picture of the party, as they stood around him in the moonlight, dipping eagerly into his bucket, and drinking in turn until they had exhausted the supply, is so vivid, that one shares their good spirits and their enjoyment. Thus refreshed, they started on the last stage of

their journey, three leagues of which yet lay before them, and at half-past eleven arrived at the chalets of Méril, which they had left at dawn.

On the morrow the party broke up, and Agassiz and Desor, accompanied by their friend, M. Escher de la Linth, returned to the Grimsel, and after a day's rest there repaired once more to the Hôtel des Neuchâtelois. They remained on the glacier until the 5th of September, spending these few last days in completing their measurements, and in planting the lines of stakes across the glacier, to serve as a means of determining its rate of movement during the year, and the comparative rapidity of that movement at certain fixed points. Thus concluded one of the most eventful seasons Agassiz and his companions had yet passed upon the Alps.[1]

[1] Though quoting his exact language only in certain instances, the account of this and other Alpine ascensions described above has been based upon M. E. Desor's *Séjours dans les Glaciers*. His very spirited narratives, added to my own recollections of what I had heard from Mr. Agassiz himself on the same subject, have given me my material. — E. C. A.

CHAPTER XI.

1842 - 1843 : ÆT. 35 - 36.

Zoölogical Work uninterrupted by Glacial Researches. — Various Publications. — "Nomenclator Zoölogicus." — "Bibliographia Zoölogiæ et Geologiæ." — Correspondence with English Naturalists. — Correspondence with Humboldt. — Glacial Campaign of 1842. — Correspondence with Prince de Canino concerning Journey to United States. — Fossil Fishes from the Old Red Sandstone. — Glacial Campaign of 1843. — Death of Leuthold, the Guide.

ALTHOUGH his glacier work was now so prominent a feature of Agassiz's scientific life, his zoölogical studies, especially his ichthyological researches, and more especially his work on fossil fishes, went on with little interruption. His publications upon Fossil Mollusks,[1] upon Tertiary Shells,[2] upon Living and Fossil Echinoderms,[3] with many smaller monographs on special subjects, were undertaken

[1] *Etudes Critiques sur les Mollusques Fossiles*, 4 nos., 4°, with 100 plates.

[2] *Iconographie des Coquilles Tertiaires réputées identiques sur les vivans*, 1 no., 4°, 14 plates.

[3] *Monographie d'Echinodermes vivans et fossiles*, 4 nos., 4°, with 37 plates.

and completed during the most active period of his glacial investigations. More surprising is it to find him, while pursuing new lines of investigation with passionate enthusiasm, engaged at the same time upon works seemingly so dry and tedious as his "Nomenclator Zoologicus," and his "Bibliographia Zoölogiæ et Geologiæ."

The former work, a large quarto volume with an Index,[1] comprised an enumeration of all the genera of the animal kingdom, with the etymology of their names, the names of those who had first proposed them, and the date of their publication. He obtained the coöperation of other naturalists, submitting each class as far as possible for revision to the leaders in their respective departments.

In his letter of presentation to the library of the Neuchâtel Academy, addressed to M. le Baron de Chambrier, President of the Academic Council, Agassiz thus describes the Nomenclator.

. . . "Have the kindness to accept for the library of the Academy the fifth number of a work upon the sources of zoölogical criticism, the publication of which I have just begun. It is a work of patience, demanding

[1] The Index was also published separately as an octavo.

long and laborious researches. I had conceived the plan in the first years of my studies, and since then have never lost sight of it. I venture to believe it will be a barrier against the Babel of confusion which tends to overwhelm the domain of zoölogical synonymy. My book will be called 'Nomenclator Zoölogicus.'" . . .

The Bibliographia (4 volumes, 8°) was in some measure a complement of the Nomenclator, and contained a list of all the authors named in the latter, with notices of their works. It appeared somewhat later, and was published by the Ray Society in England, in 1848, after Agassiz had left Europe for the United States. The material for this work also had been growing upon his hands for years. Feeling more and more the importance of such a register as a guide for students, he appealed to naturalists in all parts of Europe for information upon the scientific bibliography of their respective countries, and at last succeeded in cataloguing, with such completeness as was possible, all known works and all scattered memoirs on zoölogy and geology. Unable to publish this costly but unremunerative material, he was delighted to

give it up to the Ray Society. The first three volumes were edited with corrections and additions by Mr. H. E. Strickland, who died before the appearance of the fourth volume, which was finally completed under the care of his father-in-law, Sir William Jardine.

The ability, so eminently possessed by Agassiz of dealing with a number of subjects at once, was due to no superficial versatility. To him his work had but one meaning. It was never disconnected in his thought, and therefore he turned from his glaciers to his fossils, and from the fossil to the living world, with the feeling that he was always dealing with kindred problems, bound together by the same laws. Nowhere is this better seen than in the records of the scientific society of Neuchâtel, the society he helped to found in the first months of his professorship, and to which he always remained strongly attached, being a constant attendant at its sessions from 1833 to 1846. Here we find him from month to month, with philosophic breadth of thought, treating of animals in their widest relations, or describing minute structural details with the skill of a specialist. He presents organized beings in their geological succession, in their

geographical distribution, in their embryonic development. He reviews and remodels laws of classification. Sometimes he illustrates the fossil by the living world, sometimes he finds the key to present phenomena in the remote past. He reconstructs the history of the glacial period, and points to its final chapter in the nearest Alpine valleys, connecting these facts again with like phenomena in distant parts of the globe. But however wide his range and however various his topics, under his touch they are all akin, all coördinate parts of a whole which he strives to understand in its entirety. A few extracts from his correspondence will show him in his different lines of research at this time.

The following letter is from Edward Forbes, one of the earliest explorers of the deep-sea fauna. Agassiz had asked him for some help in his work upon echinoderms.

EDWARD FORBES TO LOUIS AGASSIZ.

21 Lothian St., Edinburgh, *February* 13, 1841.

. . . A letter from you was to me one of the greatest of pleasures, and with great delight (though, I fear, imperfectly) I have executed the commission you gave me. It should have been done much sooner had not the

storms been so bad in the sea near this that, until three days ago, I was not able to procure a living sea-urchin from which to make the drawings required. . . . You have made all the geologists glacier-mad here, and they are turning Great Britain into an ice-house. Some amusing and very absurd attempts at opposition to your views have been made by one or two pseudo-geologists; among others, poor ——, who has read a paper at the Royal Society here, maintaining that all the appearances you refer to glaciers were caused by blocks of ice which floated this way in the Deluge! and that the fossils of the pleistocene strata were mollusks, etc., which, climbing upon the ice-blocks, were carried to warmer seas against their will!! To my mind, one of the best proofs of the truth of your views lies in the decidedly arctic character of the pleistocene fauna, which must be referred to the glacier time, and by such reference is easily understood. I mean during the summer to collect data on that point, in order to present a mass of geological proofs of your theory.

Dr. Traill tells me you are proposing to visit England again during the coming summer. If you do, I hope we shall meet, when I shall have many things to show you, which

time did not permit when you were here. I look anxiously for the forth-coming number of your history of the Echinodermata. . . .

FROM SIR RODERICK MURCHISON.

June 13, 1842.

. . . Your letters have given me great pleasure: first, in assuring me that your zeal in ichthyology is undiminished, and that you are about to give such striking proofs of it to the British Association; and next that you still pursue with enthusiasm your admirable researches upon the glaciers. I should be charmed to put myself under your guidance for a walk on the glaciers of the Aar, but I hardly dare promise it yet. . . . Even were I to make every haste, I doubt if it be possible to reach your Swiss meeting in time. It is just possible that I may find you in your glacial cantonment after your return, but even this will depend upon circumstances over which I have no control.

I send this letter to you by my friend, Admiral Sir Charles Malcolm, who passes through Neuchâtel on his way to Geneva. Accompanying it is a copy of my last discourse, which I request you to accept and to read all parts of it. You will see that I have grappled

honestly and according to my own faith with your ice, but have never lost sight of your great merit. My concluding paragraph will convince you and all your friends that if I am wrong it is not from any preconceived notions, but only because I judge from what you will call incomplete evidence. Your "Venez voir!" still sounds in my ears. . . .

Murchison remained for many years an opponent of the glacial theory in its larger application. In the discourse to which the above letter makes allusion (Address at the Anniversary Meeting of the Geological Society of London, 1842 [1]) is this passage: "Once grant to Agassiz that his deepest valleys of Switzerland, such as the enormous Lake of Geneva, were formerly filled with snow and ice, and I see no stopping place. From that hypothesis you may proceed to fill the Baltic and the northern seas, cover southern England and half of Germany and Russia with similar icy sheets, on the surfaces of which all the northern boulders might have been shot off. So long as the greater number of the practical geologists of Europe are opposed to the wide extension of

[1] Extract from Report in vol. 33 of the *Edinburgh New Philosophical Journal.*

a terrestrial glacial theory, there can be little risk that such a doctrine should take too deep a hold of the mind. . . . The existence of glaciers in Scotland and England (I mean in the Alpine sense) is not, at all events, established to the satisfaction of what I believe to be by far the greater number of British geologists."

Twenty years later, with rare candor, Murchison wrote to Agassiz as follows; by its connection, though not by its date, the extract is in place here: "I send you my last anniversary address, which I wrote entirely myself; and I beg you to believe that in the part of it that refers to the glacial period, and to Europe as it was geographically, I have had the sincerest pleasure in avowing that I was wrong in opposing as I did your grand and original idea of my native mountains. Yes! I am now convinced that glaciers did descend from the mountains to the plains as they do now in Greenland."

During the summer of 1842, at about the same date with Murchison's letter disclaiming the glacial theory, Agassiz received, on the other hand, a new evidence, and one which must have given him especial pleasure, of the favorable impression his views were making in some quarters in England.

FROM DR. BUCKLAND.

OXFORD, *July* 22, 1842.

. . . You will, I am sure, rejoice with me at the adhesion of C. Darwin to the doctrine of ancient glaciers in North Wales, of which I send you a copy, and which was communicated to me by Dr. Tritten, during the late meeting at Manchester, in time to be quoted by me versus Murchison, when he was proclaiming the exclusive agency of floating icebergs in drifting erratic blocks and making scratched and polished surfaces. It has raised the glacial theory fifty per cent., as far as relates to glaciers descending inclined valleys; but Hopkins and the Cantabrigians are still as obstinate as ever against allowing the power of expansion to move ice along great distances on horizontal surfaces. . . .

The following is the letter referred to above.

C. DARWIN TO DR. TRITTEN.

Yesterday (and the previous days) I had some most interesting work in examining the marks left by *extinct* glaciers. I assure you, an extinct volcano could hardly leave more evident traces of its activity and vast powers.

I found one with the lateral moraine quite perfect, which Dr. Buckland did not see. Pray if you have any communication with Dr. Buckland give him my warmest thanks for having guided me, through the published abstract of his memoir, to scenes, and made me understand them, which have given me more delight than I almost remember to have experienced since I first saw an extinct crater. The valley about here and the site of the inn at which I am now writing must once have been covered by at least 800 or 1,000 feet in thickness of solid ice! Eleven years ago I spent a whole day in the valley where yesterday everything but the ice of the glaciers was palpably clear to me, and I then saw nothing but plain water and bare rock. These glaciers have been grand agencies. I am the more pleased with what I have seen in North Wales, as it convinces me that my view of the distribution of the boulders on the South American plains, as effected by floating ice, is correct. I am also more convinced that the valleys of Glen Roy and the neighboring parts of Scotland have been occupied by arms of the sea, and very likely (for in that point I cannot, of course, doubt Agassiz and Buckland) by glaciers also.

It continued to be a grief to Agassiz that Humboldt, the oldest of all his scientific friends, and the one whose opinion he most reverenced, still remained incredulous. Humboldt's letters show that Agassiz did not willingly renounce the hope of making him a convert. Agassiz's own letters to Humboldt are missing from this time onward. Overwhelmed with occupation, and more at his ease in his relations with the older scientific men, he had ceased to make the rough drafts in which his earlier correspondence is recorded.

HUMBOLDT TO AGASSIZ.

BERLIN, *March* 2, 1842.

. . . When one has been so long separated, even accidentally, from a friend as I have been from you, my dear Agassiz, it is difficult to find beginning or end to a letter. The kindly remembrance which you send me is evidence that my long silence has not seemed strange to you. . . . It would be wasting words to tell you how I have been prevented, by the distractions of my life, always increasing with old age, from acknowledging the admirable things received from you, — upon living and fossil fishes, echinoderms, and glaciers. My admiration of your

boundless activity, of your beautiful intellectual life, increases with every year. This admiration for your work and your bold excursions is based upon the most careful reading of all the views and investigations, for which I have to thank you. This very week I have read with great satisfaction your truly philosophical address, and your long treatise in Cotta's fourth "Jahresschrift." Even L. von Buch confessed that the first half of your treatise, the living presentation of the succession of organized beings, was full of truth, sagacity, and novelty.

I in no way reproach you, my dear friend, for the urgent desire expressed in all your letters, that your oldest friends should accept your comprehensive geological view of your ice-period. It is very noble and natural to wish that what has impressed us as true should also be recognized by those we love. . . . I believe I have read and compared all that has been written for and against the ice-period, and also upon the transportation of boulders, whether pushed along or carried by floods or gliding over slopes. My own opinion, as you know, can have no weight or authority, since I have not myself seen the most decisive points. Indeed I am, perhaps

wrongly, inclined to look upon all geological theories as having their being in a mythical region, in which, with the progress of physics, the phantasms are modified century by century. But the "elephants caught in the ice," and Cuvier's "instantaneous change of climate," seem to me no more intelligible to-day than when I wrote my Asiatic fragments. According to all that we know of the decrease of heat in the earth, I cannot understand such a change of temperature in a space of time which does not also allow for the decaying of flesh. I understand much better how wolves, hares, and dogs, should they fall to-day into clefts of the frozen regions of Northern Siberia (and the so-called "elephant-ice" is in plain prose only porphyritic drift mixed with ice-crystals, true drift material), might retain their flesh and muscles. . . . But I am only a grumbling rebellious subject in your kingdom. . . . Do not be vexed with a friend who is more than ever impressed with your services to geology, your philosophical views of nature, your profound knowledge of organized beings. . . .

With old attachment and the warmest friendship, your

A. DE HUMBOLDT.

In the same strain is this extract from another letter of Humboldt's, written two or three months later.

. . . "'Grace from on high,' says Madame de Sévigné, 'comes slowly.' I especially desire it for the glacial period and for that fatal cap of ice which frightens me, child of the equator that I am. My heresy, of little importance, since I have seen nothing, does not, I assure you, my dear Agassiz, diminish my ardent desire that all your observations should be published. . . . I rejoice in the good news you give me of the fishes. I should pain you did I add that this work of yours, by the light it has shed on the organic development of animals, makes the true foundation of your glory." . . .

LOUIS AGASSIZ TO SIR PHILIP EGERTON.

NEUCHÂTEL, *June*, 1842.

. . . I am hard at work on the fishes of the "Old Red," and will send you at Manchester a part at least of the plates, with a general summary of the species of that formation. I aim to finish the work with such care that it shall mark a sensible advance in ichthyology. I hope it will satisfy you. . . . You ask me how I intend to finish my Fossil Fishes? As fol-

lows: As soon as the number on the species of the "Old Red" is finished, I shall complete the general outline of the work as I did with volume 4, in order that the arrangement and character of all the families in the four orders may be studied in their zoölogical affinities, with their genera and principal species. But as this outline can no longer contain the innumerable species now known to me, I take up monographically the species from the different geological formations in the order of the deposits, and publish as many supplements as there are great formations rich in fossil fishes. I shall limit myself to the species described in the body of the work, merely adding the description of the new species in each deposit, and such additions as I may have to make for those already known. In this way, those who wish to study fossil fishes from the zoölogical stand-point can turn to the work in the original form, while those who wish to study them in their geological relations can confine themselves to the supplements. By means of double registers at the end of each volume, these two distinct parts of the work will be again united as a complete whole. This is the only plan I have been able to devise by which I could publish

in succession all my materials without burdening my first subscribers, who will thus be free to accept the supplements or not, as they prefer. Should you have occasion to mention this arrangement to the friends of fossil ichthyology, pray do so; it seems to me for the interest of the matter that it should be known. . . . I propose to resume with new zeal my researches upon the fossil fishes as soon as I return from an excursion I wish to make in July and August to the glacier of the Aar, where I hope, by a last visit this year, to conclude my labors on this subject. You will be glad to learn that the beautiful barometer you gave me has been my faithful companion in the Alps. . . . I have the pleasure to tell you that the King of Prussia has made me a handsome gift of nearly £200 for the continuance of my glacial work. I feel, therefore, the greater certainty of completing what remains for me to do. . . .

The campaign of 1842 opened on the 4th of July. The boulder had ceased to be a safe shelter, and was replaced by a rough frame cabin covered with canvas. If the party had some regrets in leaving their picturesque hut beneath the rock, the greater

comfort of the new abode consoled them. It had several divisions. A sleeping-place for the guides and workmen was partitioned off from a middle room occupied by Agassiz and his friends, while the front space served as dining-room, sitting-room, and laboratory. This outer apartment boasted a table and one or two benches; even a couple of chairs were kept as seats of honor for occasional guests. A shelf against the wall and a few pegs accommodated books, instruments, coats, etc., and a plank floor, on which to spread their blankets at night, was a good exchange for the frozen surface of the glacier.[1]

[1] In bidding farewell to the boulder which had been the first "Hôtel des Neuchâtelois" we may add a word of its farther fortunes. It had begun to split in 1841, and was completely rent asunder in 1844, after which frost and rain completed its dismemberment. Strange to say, during the last summer (1884) certain fragments of the mass have been found, inscribed with the names of some of the party; one of the blocks bearing beside names, the mark *No.* 2. The account says: "The middle stone, the one numbered 2, was at the intersecting point of two lines drawn from the Pavilion Dollfuss to the Scheuchzerhorn on the one part, and from the Rothhorn to the Thierberg on the other." According to the measurements taken by Agassiz, the Hôtel des Neuchâtelois in 1840 stood at 797 mètres from the promontory of Abschwung. We are thus enabled, by referring to the large glacier map of Wild and Stengel, to compare the present with the then position of the stone, and thereby ascertain the progress of the glacier since the time in question. Thus the

Mr. Wild, an engineer of known ability, was now a member of their party, as a topographical survey was to be one of the chief objects of the summer's work. The results of this survey, which was continued during two summers, are embodied in the map accompanying Agassiz's "Système Glaciaire." Experiments upon the extent and connection of the net-work of capillary fissures that admitted water into the interior of the glaciers, occupied Agassiz's own attention during a great part of the summer. In order to ascertain this, colored liquids were introduced into the glacier by means of boring, and it was found that they threaded their way through the mass of the ice and reappeared at lower points with astonishing rapidity. A gallery was cut at a depth of ten metres below the surface, through a wall of ice intervening between two crevasses. The colored liquid poured into a hole above soon appeared on the ceiling of the gallery. The experimenters were surprised to find that at night the same result was obtained, and that the liquid penetrated from the surface to the roof of the gallery even more quickly

boulder still contributes something toward the sequel of the work begun by those who once found shelter beneath it. — E. C. A.

than during the day. This was explained by the fact that the fissures were then free from any moisture arising from surface melting, so that the passage through them was unimpeded.[1]

The comparative rate of advance in the different parts of the glacier was ascertained this summer with greater precision than before. The rows of stakes planted in a straight line across the glacier by Agassiz and Escher de la Linth, in the previous September, now described a crescent with the curve turned toward the terminus of the glacier, showing, contrary to the expectation of Agassiz, that the centre moved faster than the sides. The

[1] Distrust has been thrown upon these results by the failure of more recent attempts to repeat the same experiments. In reference to this, Agassiz himself says: "The infiltration has been denied in consequence of the failure of some experiments in which an attempt was made to introduce colored fluids into the glacier. To this I can only answer that I succeeded completely myself in the self-same experiment which a later investigator found impracticable, and that I see no reason why the failure of the latter attempt should cast a doubt upon the success of the former. The explanation of the difference in the result may perhaps be found in the fact that as a sponge gorged with water can admit no more fluid than it already contains, so the glacier, under certain circumstances, and especially at noonday in summer, may be so soaked with water that all attempts to pour colored fluids into it would necessarily fail."—See *Geological Sketches*, by L. Agassiz, p. 236.

SECOND STATION ON THE AAR GLACIER

correspondence of the curve in the stratification with that of the line of stakes confirmed this result. The study of the stratification of the snow was a marked feature of the season's work, and Agassiz believed, as will be seen by a later letter, that he had established this fact of glacial structure beyond a doubt.

The origin and mode of formation of the crevasses also especially occupied the observers. On the 7th of August, Agassiz had an opportunity of watching this phenomenon in its initiation. Attracted to a certain spot on the glacier by a commotion among his workmen, he found them alarmed at the singular noises and movements in the ice. "I heard," he says, "at a little distance a sound like the simultaneous discharge of fire-arms; hurrying in the direction of the noise, it was repeated under my feet with a movement like that of a slight earthquake; the ground seemed to shift and give way under me, but now the sound differed from the preceding, and resembled a crumbling of rocks, without, however, any perceptible sinking of the surface. The glacier actually trembled, nevertheless; for a block of granite three feet in diameter, perched on a pedestal two feet high, suddenly fell down. At the same instant a

crack opened between my feet and ran rapidly across the glacier in a straight line."[1] On this occasion Agassiz saw three crevasses formed in an hour and a half, and heard others opening at a greater distance from him. He counted eight new fissures in a space of one hundred and twenty-five feet. The phenomenon continued throughout the evening, and recurred, though with less frequency, during the night. The cracks were narrow, the largest an inch and a half in width, and their great depth was proved by the rapidity with which they drained any standing water in their immediate vicinity. "A boring-hole," says Agassiz, "one hundred and thirty feet deep and six inches in diameter, full of water, was completely emptied in a few minutes, showing that these narrow cracks penetrated to great depths."

The summer's work included observations also on the comparative movement of the glacier during the day and night, on the surface waste of the mass, its reparation, on the névé and snow of the upper regions, on the meridian holes, the sun-dials of the glaciers, as they

[1] Extract from a letter of Louis Agassiz to M. Arago dated from the Hôtel des Neuchâtelois, Glacier of the Aar, August 7, 1842.

have been called.[1] On the whole, the most important result of the campaign was the topographical survey of the glacier, recorded in the map published in Agassiz's second work on the glacier.

At about this time there begin to be occasional references in his correspondence to a journey of exploration in the United States. Especially was this plan in frequent discussion between him and Charles Bonaparte, Prince of Canino, a naturalist almost as ardent as himself, with whom he had long been in intimate scientific correspondence. In April, 1842, the prince writes him: "I indulge myself in dreaming of the journey to America in which you have promised to accompany me.

[1] "Here and there on the glacier there are patches of loose material, dust, sand, or gravel, accumulated by diminutive water-rills and small enough to become heated during the day. They will, of course, be warmed first on their eastern side, then still more powerfully on their southern side, and, in the afternoon, with less force again, on their western side, while the northern side will remain comparatively cool. Thus around more than half of their circumference they melt the ice in a semicircle, and the glacier is covered with little crescent-shaped troughs of this description, with a steep wall on one side and a shallow one on the other, and a little heap of loose materials in the bottom. They are the sun-dials of the glacier, recording the hour by the advance of the sun's rays upon them." — *Geological Sketches*, by L. Agassiz, p. 293.

What a relaxation! and at the same time what an amount of useful work!" Again, a few months later, "You must keep me well advised of your plans, and I, in my turn, will try so to arrange my affairs as to find myself free in the spring of 1844 for a voyage, the chief object of which will be to show my oldest son the country where he was born, and where man may develop free of shackles. The mere anticipation of this journey is delightful to me, since I shall have you at my side, and may thus feel sure that it will make an epoch in science." This letter is answered from the glacier; the first part refers to the Nomenclator, in regard to which he often consulted the prince.

LOUIS AGASSIZ TO THE PRINCE OF CANINO.

GLACIER OF THE AAR, *September* 1, 1842.

. . . I thank you most sincerely for the pains you have so kindly taken with my proof, and for pointing out the faults and omissions you have noticed in my register of birds. I made the corrections at once, and have taken the liberty of mentioning on the cover of this number the share you have consented to take in my Nomenclator. I shall try to do better and better in the successive classes, but you

well know the impossibility of avoiding grave errors in such a work, and that they can be wholly weeded out only in a second and third edition. I should have written sooner in answer to your last, had not your letter reached me on the Glacier of the Aar, where I have been since the beginning of July, following up observations, the results of which become every day more important and more convincing. The most striking fact, one which I think I have placed beyond the reach of doubt, is the primitive stratification of the névé, or fields of snow, — stratified from the higher régions across the whole course of the glacier to its lower extremity. I have prepared a general map, with transverse sections, showing how the layers lift themselves on the borders of the glacier and also at their junction, where two glaciers meet at the outlet of adjoining valleys; and how, also, the waving lines formed by the layers on the surface change to sharper concentric curves with a marked axis, as the glacier descends to lower levels. For a full demonstration of the matter, I ought to send you my map and plans, of which I have, as yet, no duplicates; but the fact is incontestable, and you will oblige me by announcing it in the geological section at Padua. M.

Charpentier, who is going to your meeting, will contest it, but you can tell him from me that it is as evident as the stratification of the Neptunic rocks. To see and understand it fully, however, one must stand well above the glacier, so as to command the surface as a whole in one view. I would add that I am not now alluding to the blue and white bands in the ice of which I spoke to you last year; this is a quite distinct phenomenon.

I wish I could accept your kind invitation, but until I have gone to the bottom of the glacier question and terminated my "Fossil Fishes," I do not venture to move. It is no light task to finish all this before our long journey, to which I look forward, as it draws nearer, with a constantly increasing interest. I am very sorry not to join you at Florence. It would have been a great pleasure for me to visit the collections of northern Italy in your company. . . . I write you on a snowy day, which keeps me a prisoner in my tent; it is so cold that I can hardly hold my pen, and the water froze at my bedside last night. The greatest privation is, however, the lack of fruit and vegetables. Hardly a potato once a fortnight, but always and every day, morning and night, mutton, everlasting mutton,

and rice soup. As early as the end of July we were caught for three days by the snow; I fear I shall be forced to break up our encampment next week without having finished my work. What a contrast between this life and that of the plain! I am afraid my letter may be long on the road before reaching the mail, and I pause here that I may not miss the chance of forwarding it by a man who has just arrived with provisions and is about to return to the hospice of the Grimsel, where some trustworthy guide will undertake to deliver it at the first post-office.

No sooner is Agassiz returned from the glacier than we meet him again in the domain of his fossil fishes.

LOUIS AGASSIZ TO SIR PHILIP EGERTON.

NEUCHÂTEL, *December* 15, 1842.

. . . In the last few months I have made an important step in the identification of fossil fishes. The happy idea occurred to me of applying the microscope to the study of fragments of their bones, especially those of the head, and I have found in their structure modifications as remarkable and as numerous as those which Mr. Owen discovered in the

structure of teeth. Here there is a vast new field to explore. I have already applied it to the identification of the fossil fishes in the Old Red of Russia sent me for that purpose by Mr. Murchison. You will find more ample details about it in my report to him. I congratulate myself doubly on the results; first, because of their great importance in paleontology, and also because they will draw more closely my relations with Mr. Owen, whom I always rejoice to meet on the same path with myself, and whom I believe incapable of jealousy in such matters. . . . The only point indeed, on which I think I may have a little friendly difference with him, is concerning the genus Labyrinthodon, which I am firmly resolved, on proofs that seem to me conclusive, to claim for the class of fishes.[1] As soon as I have time I will write to Mr. Owen, but this need not prevent you from speaking to him on the subject if you have an early opportunity to do so. I am now exclusively occupied with the fossil fishes, which at any cost I wish to finish this winter. . . . Before even returning to my glacier work, I will finish my monograph of the Old Red, so that you may present it at

[1] On seeing Owen's evidence some years later, Agassiz at once acknowledged himself mistaken on this point.

the Cork meeting, which it will be impossible for me to attend. . . . I am infinitely grateful to you and Lord Enniskillen for your willingness to trust your Sheppy fishes to me; I shall thus be prepared in advance for a strict determination of these fossils. Having them for some time before my eyes, I shall become familiar with all the details. When I know them thoroughly, and have compared them with the collections of skeletons in the Museums of Paris, of Leyden, of Berlin, and of Halle, I will then come to England to see what there may be in other collections which I cannot have at my disposal here.

The winter of 1843, apart from his duties as professor, was devoted to the completion of the various zoölogical works on which he was engaged, and to the revision of materials he had brought back from the glacier. His habits with reference to physical exercise were very irregular. He passed at once from the life of the mountaineer to that of the closet student. After weeks spent on the snow and ice of the glacier, constantly on foot and in the open air, he would shut himself up for a still longer time in his laboratory, motionless for hours at his microscope by day, and writ-

ing far into the night, rarely leaving his work till long after midnight. He was also forced at this time to press forward his publications in the hope that he might have some return for the sums he had expended upon them. This was indeed a very anxious period of his life. He could never be brought to believe that purely intellectual aims were not also financially sound, and his lithographic establishment, his glacier work, and his costly researches in zoölogy had proved far beyond his means. The prophecies of his old friend Humboldt were coming true. He was entangled in obligations, and crushed under the weight of his own undertakings. He began to doubt the possibility of carrying out his plan of a scientific journey to the United States.

AGASSIZ TO THE PRINCE OF CANINO.

NEUCHÂTEL, *April*, 1843.

. . . I have worked like a slave all winter to finish my fossil fishes; you will presently receive my fifteenth and sixteenth numbers, forwarded two days since, with more than forty pages of text, containing many new observations. I shall allow myself no interruption until this work is finished, hoping there-

by to obtain a little freedom, for if my position here is not changed I shall be forced to seek the means of existence elsewhere. Meantime, extravagant projects present themselves, as is apt to be the case when one is in difficulties. That of accompanying you to the United States was so tempting, that I am bitterly disappointed to think that its execution becomes impossible in my present circumstances. All my projects for further publications must also be adjourned, or perhaps renounced. . . . Possibly, when my work on the fossil fishes is completed, the sale of some additional copies may help me to rise again. And yet I have not much hope of this, since all the attempts of my friends to obtain subscriptions for me in France and Russia have failed: because the French government takes no interest in what is done out of Paris; and in Russia such researches, having little direct utility, are looked upon with indifference. Do you think any position would be open to me in the United States, where I might earn enough to enable me to continue the publication of my unhappy books, which never pay their way because they do not meet the wants of the world? . . .

In the following July we find him again upon the glacier. But the campaign of 1843 opened sadly for the glacial party. Arriving at Meiringen they heard that Jacob Leuthold was ill and would probably be unable to accompany them. They went to his house, and found him, indeed, the ghost of his former self, apparently in a rapid decline. Nevertheless, he welcomed them gladly to his humble home, and would have kept them for some refreshment. Fearing to fatigue him, however, they stayed but a few moments. As they left, one of the party pointed to the mountains, adding a hope that he might soon join them. His eyes filled with tears; it was his only answer, and he died three days later. He was but thirty-seven years of age, and at that time the most intrepid and the most intelligent of the Oberland guides. His death was felt as a personal grief by the band of workers whose steps he had for years guided over the most difficult Alpine passes.

The summer's work continued and completed that of the last season. On leaving the glacier the year before they had marked a net-work of loose boulders, such as travel with the ice, and also a number of fixed points in the valley walls, comparing and registering

their distance from each other. They had also sunk a line of stakes across the glacier. The change in the relative position of the two sets of signals and the curve in their line of stakes gave them, self-recorded, as it were, the rate of advance of the glacier as a whole, and also the comparative rate of progression in its different parts. Great pains was also taken during the summer to measure the advance in every twenty-four hours, as well as to compare the diurnal with the nocturnal movement, and to ascertain the amount of surface waste. The season was an unfavorable one, beginning so late and continuing so cold that the period of work was shortened.

CHAPTER XII.

1843–1846: ÆT. 36–39.

Completion of Fossil Fishes. — *Followed by Fossil Fishes of the Old Red Sandstone.* — *Review of the Latter Work.* — *Metamorphosis of Fishes by the Skull.* — *Renewed Correspondence with Prince Canino about Journey to the United States.* — *Change of Plan owing to the Interest of the King of Prussia in the Expedition.* — *Correspondence between Professor Sedgwick and Agassiz on Development Theory.* — *Fine Scientific Work in Neuchâtel and Paris.* — *Publication of "Système glaciaire."* — *Short Stay in England.* — *Sails for United States.*

In 1843 the "Recherches sur les Poissons Fossiles" was completed, and fast upon its footsteps, in 1844, followed the author's "Monograph on the Fossil Fishes of the Old Red Sandstone, or the Devonian System of Great Britain and Russia," a large quarto volume of text, accompanied by forty-one plates. Nothing in his paleontological studies ever interested Agassiz more than this curious fauna of the Old Red, so strange in its combinations that even well-informed naturalists had attributed its fossil remains to various classes of the animal kingdom in turn, and, indeed, long

remained in doubt as to their true nature. Agassiz says himself in his Preface: "I can never forget the impression produced upon me by the sight of these creatures, furnished with appendages resembling wings, yet belonging, as I had satisfied myself, to the class of fishes. Here was a type entirely new to us, about to reënter (for the first time since it had ceased to exist) the series of beings; nor could anything, thus far revealed from extinct creations, have led us to anticipate its existence. So true is it that observation alone is a safe guide to the laws of development of organized beings, and that we must be on our guard against all those systems of transformation of species so lightly invented by the imagination."

The author goes on to state that the discovery of these fossils was mainly due to Hugh Miller, and that his own work had been confined to the identification of their character and the determination of their relations to the already known fossil fishes. This work, upon a type so extraordinary, implied, however, innumerable and reiterated comparisons, and a minute study of the least fragments of the remains which could be procured. The materials were chiefly obtained in Scotland; but Sir Roderick Murchison also contributed his own

collection from the Old Red of Russia, and various other specimens from the same locality. Not only on account of their peculiar structure were the fishes of the Old Red interesting to Agassiz, but also because, with this fauna, the vertebrate type took its place for the first time in what were then supposed to be the most ancient fossiliferous beds. When Agassiz first began his researches on fossil fishes, no vertebrate form had been discovered below the coal. The occurrence of fishes in the Devonian and Silurian beds threw the vertebrate type back, as he believed, into line with all the invertebrate classes, and seemed to him to show that the four great types of the animal kingdom, Radiates, Mollusks, Articulates, and Vertebrates, had appeared together.[1] "It is henceforth demonstrated," says Agassiz, "that the fishes were included in the plan of the first organic combinations which made the point of departure for all the living inhabitants of our globe in the series of time."

In his opinion this simultaneity of appearance, as well as the richness and variety displayed by invertebrate classes from the begin-

[1] Introduction to the *Poissons Fossiles du Vieux Grès Rouge*, p. 22.

ning, made it[1] "impossible to refer the first inhabitants of the earth to a few stocks, subsequently differentiated under the influence of external conditions of existence." . . . He adds:[2] "I have elsewhere presented my views upon the development through which the successive creations have passed during the history of our planet. But what I wish to prove here, by a careful discussion of the facts reported in the following pages, is the truth of the law now so clearly demonstrated in the series of vertebrates, that the successive creations have undergone phases of development analogous to those of the embryo in its growth and similar to the gradations shown by the present creation in the ascending series, which it presents as a whole. One may consider it as henceforth proved that the embryo of the fish during its development, the class of fishes as it at present exists in its numerous families, and the type of fish in its planetary history, exhibit analogous phases through which one may follow the same creative thought like a guiding thread in the study of the connection

[1] Introduction to the *Poissons Fossiles du Vieux Grès Rouge*, p. 21.

[2] Introduction to the *Poissons Fossiles du Vieux Grès Rouge*, p. 24.

between organized beings." Following this comparison closely, he shows how the early embryonic condition of the present fishes is recalled by the general disposition of the fins in the fishes of the Old Red Sandstone, and especially by the caudal fin, making the unevenly lobed tail, so characteristic of these ancient forms. This so called heterocercal tail is only known to exist, as a permanent adult feature, in the sturgeons of to-day. The form of the head and the position of the mouth and eyes in the fishes of the Old Red were also shown to be analogous with embryonic phases of our present fishes. From these analogies, and also from the ascendency of fishes as the only known vertebrate, and therefore as the highest type in those ancient deposits, Agassiz considered this fauna as representing "the embryonic age of the reign of fishes;" and he sums up his results in conclusion in the following words: "The facts, taken as a whole, seem to me to show, not only that the fishes of the Old Red constitute an independent fauna, distinct from those of other deposits, but that they also represent in their organization the most remarkable analogy with the first phases of embryonic development in the bony fishes of our epoch, and a no less

marked parallelism with the lower degrees of certain types of the class as it now exists on the surface of the earth."

It has been said by one of the biographers of Agassiz,[1] in reference to this work upon the fishes of the Old Red Sandstone: "It is difficult to understand why the results of these admirable researches, and of later ones made by him, did not in themselves lead him to support the theory of transformation, of which they seem the natural consequence." It is true that except for the frequent allusion to a creative thought or plan, this introduction to the Fishes of the Old Red might seem to be written by an advocate of the development theory rather than by its most determined opponent, so much does it deal with laws of the organic world, now used in support of evolution. These comprehensive laws, announced by Agassiz in his "Poissons Fossiles," and afterward constantly reiterated by him, have indeed been adopted by the writers on evolution, though with a wholly different interpretation. No one saw more clearly than Agassiz the relation which he first pointed out, between the succession of animals of the same type in time and the phases of their em-

[1] *Louis Agassiz: Notice biographique*, par Ernest Favre.

bryonic growth to-day, and he often said, in his lectures, "the history of the individual is the history of the type." But the coincidence between the geological succession, the embryonic development, the zoölogical gradation, and the geographical distribution of animals in the past and the present, rested, according to his belief, upon an intellectual coherence and not upon a material connection. So, also, the variability, as well as the constancy, of organized beings, at once so plastic and so inflexible, seemed to him controlled by something more than the mechanism of self-adjusting forces. In this conviction he remained unshaken all his life, although the development theory came up for discussion under so many various aspects during that time. His views are now in the descending scale; but to give them less than their real prominence here would be to deprive his scientific career of its true basis. Belief in a Creator was the keynote of his study of nature.

In summing up the comprehensive results of Agassiz's paleontological researches, and especially of his "Fossil Fishes," Arnold Guyot says:[1] —

"Whatever be the opinions which many

[1] See *Biographical Memoir of Louis Agassiz*, p. 28.

may entertain as to the interpretation of some of these generalizations, the vast importance of these results of Agassiz's studies may be appreciated by the incontestable fact, that nearly all the questions which modern paleontology has treated are here raised and in great measure solved. They already form a code of general laws which has become a foundation for the geological history of the life-system, and which the subsequent investigations of science have only modified and extended, not destroyed. Nowhere did the mind of Agassiz show more power of generalization, more vigor, or more originality. The discovery of these great truths is truly his work; he derived them immediately from nature by his own observations. Hence it is that all his later zoölogical investigations tend to a common aim, namely, to give by farther studies, equally conscientious but more extensive, a broader and more solid basis to those laws which he had read in nature and which he had proclaimed at that early date in his immortal work, 'Poissons Fossiles.' Let us not be astonished that he should have remained faithful to these views to the end of his life. It is because he had *seen* that he *believed*, and such a faith is not easily shaken by new hypotheses."

LOUIS AGASSIZ TO SIR PHILIP EGERTON.

NEUCHÂTEL, *September* 7, 1844.

. . . I write in all haste to ask for any address to which I can safely forward my report on the Sheppy fishes, so that they may arrive without fail in time for the meeting at York. Since my last letter I have made progress in this kind of research. I have sacrificed all my duplicates of our present fishes to furnish skeletons. I have prepared more than a hundred since I last wrote you, and I can now determine the family, and even the genus, simply by seeing the skull. There remains nothing impossible now in the determination of fishes, and if I can obtain certain exotic genera, which I have not as yet, I can make an osteology of fishes as complete as that which we possess for the other classes of vertebrates. Every family has its special type of skull. All this is extremely interesting. I have already corrected a mass of inaccurate identifications established upon external characters; and as for fossils, I have recognized and characterized seventeen new genera among the less perfect undetermined specimens you have sent me. Several families appear now for the first time among the fossils. I have been able to

determine to what family all the doubtful genera belong; indeed Sheppy will prove as rich in species as Mont Bolca. When you see your specimens again you will hardly recognize them, they are so changed; I have chiseled and cleaned them, until they are almost like anatomical preparations. Try to procure as many more specimens as possible and send them to me. I cannot stir from Neuchâtel, now that I am so fully in the spirit of work, and besides it would be a useless expense. . . . You will receive with my report the three numbers which complete my monograph of the Fishes of the Old Red. I feel sure, in advance, that you will be satisfied with them. . . .

SIR PHILIP EGERTON TO LOUIS AGASSIZ.

TOLLY HOUSE, ALNESS, ROSS-SHIRE.
September 15, 1844.

. . . I have only this day received your letter of the 6th, and I fear much you will scarcely receive this in time to make it available. I shall not be able to reach York for the commencement of the meeting, but hope to be there on Saturday, September 28th. A parcel will reach me in the shortest possible time addressed Sir P. Egerton, Donnington

Rectory, York. I am delighted with the bright results of your comparison of the Sheppy fossils with recent forms. You appear to have opened out an entirely new field of investigation, likely to be productive of most brilliant results. Should any accident delay the arrival of your monograph for the York meeting, I shall make a point of communicating to our scientific friends the contents of your letter, as I know they will rejoice to hear of the progress of fossil ichthyology in your masterly hands. When next you come, I wish you could spend a few days here. We are surrounded on all sides by the débris of the moraines of the ancient glaciers that descended the flank of Ben Wyvis, and I think you would find much to interest you in tracing their relations. We have also the Cromarty Fish-beds within a few miles, and many other objects of geological interest. . . . I shall see Lord Enniskillen at York, and will tell him of your success. We shall, of course, procure all the Sheppy fish we can either by purchase or exchange. . . .

The pressure of work upon his various publications detained Agassiz at home during the summer of 1844. For the first time he was

unable to make one of the glacial party this year, but the work was carried on uninterruptedly, and the results reported to him. Meantime his contemplated journey to the United States flitted constantly before him.

AGASSIZ TO THE PRINCE OF CANINO.

NEUCHÂTEL, *November* 19, 1844.

. . . Your idea of an illustrated American ichthyology is admirable. But for that we ought to have with us an artist clever enough to paint fishes rapidly from the life. Work but half done is no longer permissible in our days. . . . In this matter I think there is a justice due to Rafinesque. However poor his descriptions, he nevertheless first recognized the necessity of multiplying genera in ichthyology, and that at a time when the thing was far more difficult than now. Several of his genera have even the priority over those now accepted, and I think in the United States it would be easier than elsewhere to find again a part of the materials on which he worked. We must not neglect from this time forth to ask Americans to put us in the way of extending this work throughout North America. If you accept me for your collaborator, I will at once do all that I can on my

side to bring together notes and specimens. I will write to several naturalists in the United States, and tell them that as I am to accompany you on your voyage I should be glad to know in advance what they have done in ichthyology, so that we may be the better prepared to profit by our short sojourn in their country. However, I will do nothing before having your directions, which, for the sake of the matter in hand, I should be glad to receive as early as possible. . . .

The next letter announces a new aspect of the projected journey. In explanation, it should be said that finding Agassiz might be prevented by his poverty from going, the prince had invited him to be his guest for a summer in the United States.

AGASSIZ TO THE PRINCE OF CANINO.

NEUCHÂTEL, *January* 7, 1845.

. . . I have received an excellent piece of news from Humboldt, which I hasten to share with you. I venture to believe that it will please you also. . . . I had written to Humboldt of our plans, and of your kind offer to take me with you to the United States, telling him at the same time how much I regret-

ted that I should be unable to visit the regions which attracted me the most from a geological point of view, and asking him if it would be possible to interest the king in this journey and obtain means from his majesty for a longer stay on the other side of the Atlantic. I have just received a delightful and most unexpected reply. The king will grant me 15,000 francs for this object, so that I shall, in any event, be able to make the journey. All the more do I desire to make it in your society, and I think by combining our forces we shall obtain more important results; but I am glad that I can do it without being a burden to you. Before answering Humboldt, I am anxious to know whether your plans are definitely decided upon for this summer, and whether this arrangement suits you. . . .

The pleasant plan so long meditated was not to be fulfilled. The prince was obliged to defer the journey and never accomplished it. This was a great disappointment to Agassiz.

"Am I then to go without you," he writes; "is this irrevocable? If I were to defer my departure till September would it then be possible for you to leave Rome? It would be

too delightful if we could make this journey together. I wish also, before starting, to review everything that has been done of late in paleontology, zoölogy, and comparative anatomy, that I may, in behalf of all these sciences, take advantage of the circumstances in which I shall be placed. . . . Whatever befalls me, I feel that I shall never cease to consecrate my whole energy to the study of nature; its all powerful charm has taken such possession of me that I shall always sacrifice everything to it; even the things which men usually value most."

Agassiz had determined, before starting on his journey, to complete all his unfinished works, and to put in order his correspondence and collections, including the vast amount of specimens sent him for identification or for his own researches. The task of "setting his house in order" for a change which, perhaps, he dimly felt to be more momentous than it seemed, proved long and laborious. From all accounts, he performed prodigies of work, but the winter and spring passed, and the summer of 1845 found him still at his post.

Humboldt writes him not without anxiety lest his determination to complete all the tasks he had undertaken, including the Nomenclator,

should involve him in endless delays and perplexities.

HUMBOLDT TO AGASSIZ.

BERLIN, *September* 16, 1845.

. . . Your Nomenclator frightens me with its double entries. The Milky Way must have crossed your path, for you seem to be dealing with nebulæ which you are trying to resolve into stars. For pity's sake husband your strength. You treat this journey as if it were for life. As to finishing, — alas! my friend, one does not finish. Considering all that you have in your well-furnished brain beside your accumulated papers, half the contents of which you do not yourself know, your expression "aŭfräumen," — to put in final order, is singularly inappropriate. There will always remain some burdensome residue, — last things not yet accounted for. I beg you, then, not to abuse your strength. Be content to finish only what seems to you nearest completion, — the most advanced of your work.

Your letter reached me, unaccompanied, however, by the books it announces. They are to come, no doubt, in some other way. Spite of the demands made upon me by the continuation of my "Cosmos," I shall find

time to read and profit by your introduction to the Old Red. I am inclined to sing hymns of praise to the Hyperboreans who have helped you in this admirable work. What you say of the specific difference in vertical line and of the increased number of biological epochs is full of interest and wisdom. No wonder you rebel against the idea that the Baltic contains microscopic animals identical with those of the chalk! I foresee, however, a new battle of Waterloo between you and my friend Ehrenberg, who accompanied me lately, just after the Victoria festivals, to the volcanoes of the Eifel with Dechen. Not an inch of ground without infusoria in those regions! For Heaven's sake do not meddle with the infusoria before you have seen the Canada Lakes and completed your journey. Defer them till some more tranquil period of your life. . . . I must close my letter with the hope that you will never doubt my warm affection. Assuredly I shall find no fault with any course of lectures you may give in the new world, nor do I see the least objection to giving them for money. You can thus propagate your favorite views and spread useful knowledge, while at the same time you will, by most honorable and praiseworthy means, provide additional funds for your traveling expenses. . . .

The following correspondence with Professor Adam Sedgwick is of interest, as showing his attitude and that of Agassiz toward questions which have since acquired a still greater scientific importance.

PROFESSOR ADAM SEDGWICK TO LOUIS AGASSIZ.

TRINITY COLL., CAMBRIDGE,
April 10, 1845.

MY DEAR PROFESSOR,— The British Association is to meet here about the middle of June, and I trust that the occasion will again bring you to England and give me the great happiness of entertaining you in Trinity College. Indeed, I wish very much to see you; for many years have now elapsed since I last had that pleasure. May God long preserve your life, which has been spent in promoting the great ends of truth and knowledge! Your great work on fossil fishes is now before me, and I also possess the first number of your monograph upon the fishes of the Old Red Sandstone. I trust the new numbers will follow the first in rapid succession. I love now and then to find a resting-place; and your works always give me one. The opinions of Geoffroy St. Hilaire and his dark school seem to be gaining some ground in England. I

detest them, because I think them untrue. They shut out all argument from *design* and all notion of a Creative Providence, and in so doing they appear to me to deprive physiology of its life and strength, and language of its beauty and meaning. I am as much offended in taste by the turgid mystical bombast of Geoffroy as I am disgusted by his cold and irrational materialism. When men of his school talk of the elective affinity of organic types, I hear a jargon I cannot comprehend, and I turn from it in disgust; and when they talk of spontaneous generation and transmutation of species, they seem to me to try nature by an hypothesis, and not to try their hypothesis by nature. Where are their facts on which to form an inductive truth? I deny their starting condition. "Oh! but" they reply, "we have progressive development in geology." Now, I allow (as all geologists must do) a *kind* of *progressive development.* For example, the first fish are below the reptiles; and the first reptiles older than man. I say, we have successive forms of animal life adapted to successive conditions (so far, proving design), and not derived in natural succession in the ordinary way of generation. But if no single fact in actual nature allows

us to suppose that the new species and orders were produced successively in the natural way, how did they begin? I reply, by a way out of and above common known, material nature, and this way I call *creation*. Generation and creation are two distinct ideas, and must be described by two distinct words, unless we wish to introduce utter confusion of thought and language. In this view I think you agree with me; for I spoke to you on the subject when we met (alas, *ten* years since!) at Dublin. Would you have the great kindness to give me your most valuable opinion on one or two points?

(1.) Is it possible, according to the known laws of actual nature, or is it probable, on any analogies of nature, that the vast series of fish, from those of the Ludlow rock and the Old Red Sandstone to those of our actual seas, lakes, and rivers, are derived from one common original low type, in the way of development and by propagation or natural breeding? I should say, *no*. But my knowledge is feeble and at second-hand. Yours is strong and from the fountain-head.

(2.) Is the organic type of fish higher now than it was during the carboniferous period, when the Sauroids so much abounded? If

the progressive theory of Geoffroy be true, in his sense, each class of animals ought to be progressive in its organic type. It appears to me that this is not true. Pray tell me your own views on this point.

(3.) There are "*odd fish*" (as we say in jest) in the Old Red Sandstone. Do these so graduate into crustaceans as to form anything like such an organic link that one could, by generation, come naturally from the other? I should say, *no*, being instructed by your labors. Again, allowing this, for the sake of argument, are there not much higher types of fish which are contemporaneous with the lower types (if, indeed, they be lower), and do not these nobler fish of the Old Red Sandstone stultify the hypothesis of natural generative development?

(4.) Will you give me, in a few general words, your views of the scale occupied by the fish of the Old Red, considered as a natural group? Are they so rudimentary as to look like abortions or creatures derived from some inferior class, which have not yet by development reached the higher type of fish? Again, I should say, *no;* but I long for an answer from a great authority like yours. I am most anxious for a good general concep-

tion of the fish of the Old Red, with reference to some intelligible scale.

(5.) Lastly, is there the shadow of ground for supposing that by any natural generative development the Ichthyosaurians and other kindred forms of reptile have come from Sauroid, or any other type of fish? I believe you will say, *no*. At any rate, the facts of geology lend no support to such a view, for the nobler forms of Reptile appear in strata below those in which the Ichthyosaurians, etc., are first seen. But I must not trouble you with more questions. Professor Whewell is now Master of Trinity College. We shall all rejoice to see you.

Ever, my dear Professor, your most faithful and most grateful friend,

A. SEDGWICK.

FROM LOUIS AGASSIZ TO A. SEDGWICK.

NEUCHÂTEL, *June*, 1845.

. . . I reproach myself for not acknowledging at once your most interesting letter of April 10th. But you will easily understand that in the midst of the rush of work consequent upon my preparation for a journey of several years' duration I have not noticed the flight of time since I received it, until to-day,

when the sight of the date fills me with confusion. And yet, for years, I have not received a letter which has given me greater pleasure or moved me more deeply. I have felt in it and have received from it that vigor of conviction which gives to all you say or write a virile energy, captivating alike to the listener or the reader. Like you, I am pained by the progress of certain tendencies in the domain of the natural sciences; it is not only the arid character of this philosophy of nature (and by this I mean, not *natural philosophy*, but the "Natur-philosophie" of the Germans and French) which alarms me. I dread quite as much the exaggeration of religious fanaticism, borrowing fragments from science, imperfectly or not at all understood, and then making use of them to prescribe to scientific men what they are allowed to see or to find in Nature. Between these two extremes it is difficult to follow a safe road. The reason is, perhaps, that the domain of facts has not yet received a sufficiently general recognition, while traditional beliefs still have too much influence upon the study of the sciences.

Wishing to review such ideas as I had formed upon these questions, I gave a public course this winter upon the plan of creation

as shown in the development of the animal kingdom. I wish I could send it to you, for I think it might please you. Unhappily, I had no time to write it out, and have not even an outline of it. But I intend to work further upon this subject and make a book upon it one of these days. If I speak of it to-day it is because in this course I have treated all the questions upon which you ask my opinion. Let me answer them here after a somewhat aphoristic fashion.

I find it impossible to attribute the biological phenomena, which have been and still are going on upon the surface of our globe, to the simple action of physical forces. I believe they are due, in their entirety, as well as individually, to the direct intervention of a creative power, acting freely and in an autonomic way. . . . I have tried to make this intentional plan in the organization of the animal kingdom evident, by showing that the differences between animals do not constitute a material chain, analogous to a series of physical phenomena, bound together by the same law, but present themselves rather as the phases of a thought, formulated according to a definite aim. I think we know enough of comparative anatomy to abandon forever the idea of

the transformation of the organs of one type into those of another. The metamorphoses of certain animals, and especially of insects, so often cited in support of this idea, prove, by the fixity with which they repeat themselves in innumerable species, exactly the contrary. In the persistency of these metamorphoses, distinct for each species and known to repeat themselves annually in a hundred thousand species, and to have done so ever since the present order of things was established on the earth, have we not the most direct proof that the diversity of types is not due to external natural influences? I have followed this idea in all the types of the animal kingdom. I have also tried to show the direct intervention of a creative power in the geographical distribution of organized beings on the surface of the globe when the species are definitely circumscribed. As evidence of the fixity of generic types and the existence of a higher and free causal power, I have made use of a method which appears to me new as a process of reasoning. The series of reptiles, for instance, in the family of lizards, shows apodal forms, forms with rudimentary feet, then with a successively larger number of fingers until we reach, by seemingly insensible gradations,

the genera Anguis, Ophisaurus, and Pseudopus, the Chamosauria, Chirotes, Bipes, Sepo, Scincus, and at last the true lizards. It would seem to any reasonable man that these types are the transformations of a single primitive type, so closely do the modifications approach each other; and yet I now reject any such supposition, and after having studied the facts most thoroughly, I find in them a direct proof of the creation of all these species. It must not be forgotten that the genus Anguis belongs to Europe, the Ophisaurus to North America, the Pseudopus to Dalmatia and the Caspian steppe, the Sepo to Italy, etc. Now, I ask how portions of the earth so absolutely distinct could have combined to form a continuous zoölogical series, now so strikingly distributed, and whether the idea of this development could have started from any other source than a creative purpose manifested in space? These same purposes, this same constancy in the employment of means toward a final end, may be read still more clearly in the study of the fossils of the different creations. The species of all the creations are materially and genealogically as distinct from each other as those of the different points on the surface of the globe. I have compared hundreds of spe-

cies reputed identical in various successive deposits, — species which are always quoted in favor of a transition, however indirect, from one group of species to another, — and I have always found marked specific differences between them. In a few weeks I will send you a paper which I have just printed on this subject, where it seems to me this view is very satisfactorily proved. The idea of a procreation of new species by preceding ones is a gratuitous supposition opposed to all sound physiological notions. And yet it is true that, taken as a whole, there is a gradation in the organized beings of successive geological formations, and that the end and aim of this development is the appearance of man. But this serial connection of all successive creatures is not material; taken singly these groups of species show no relation through intermediate forms genetically derived one from the other. The connection between them becomes evident only when they are considered as a whole emanating from a creative power, the author of them all. To your special questions I may now very briefly reply.

Have fishes descended from a primitive type? So far am I from thinking this possible, that I do not believe there is a single

specimen of fossil or living fish, whether marine or fresh-water, that has not been created with reference to a special intention and a definite aim, even though we may be able to detect but a portion of these numerous relations and of the essential purpose.

Are the present fishes superior to the older ones? As a general proposition, I would say, *no;* it seems to me even that the fishes which preceded the appearance of reptiles in the plan of creation were higher in certain characters than those which succeeded them; and it is a strange fact that these ancient fishes have something analogous with reptiles, which had not then made their appearance. One would say that they already existed in the creative thought, and that their coming, not far removed, was actually anticipated.

Can the fishes of the Old Red be considered the embryos of those of later epochs? Of course they are the first types of the vertebrate series, including the most ancient of the Silurian system; but they each constitute an independent fauna, as numerous in the places where these earlier fishes are found, as the present fishes in any area of similar extent on our sea-shore to-day. I now know one hundred and four species of fossil fish from

the Old Red, belonging to forty-four genera, comprised under seven families, between several of which there is but little analogy as to organization. It is therefore impossible to look upon them as coming from one primitive stock. The primitive diversity of these types is quite as remarkable as that of those belonging to later epochs. It is nevertheless true that, regarded as part of the general plan of creation, this fauna presents itself as an inferior type of the vertebrate series, connecting itself directly in the creative thought with the realization of later forms, the last of which (and this seems to me to have been the general end of creation) was to place man at the head of organized beings as the key-stone and term of the whole series, the final point in the premeditated intention of the primitive plan which has been carried out progressively in the course of time. I would even say that I believe the creation of man has closed creation on this earth, and I draw this conclusion from the fact that the human genus is the first cosmopolite type in Nature. One may even affirm that man is clearly announced in the phases of organic development of the animal kingdom as the final term of this series.

Lastly: Is there any reason to believe that

the Ichthyosaurians are descendants of the Sauroid fishes which preceded the appearance of these reptiles? Not the least. I should consider any naturalist who would seriously present the question in this light as incapable of discussing it or judging it. He would place himself outside of the facts and would reason from a basis of his own creating. . . .

In the "Revue Suisse" of April, 1845, there is a notice of the course of lectures to which reference is made in the above letter.

"A numerous audience assembled on the 26th of March for the opening of a course by Professor Agassiz on the 'Plan of Creation.' It is with an ever new pleasure that our public come together to listen to this savant, still so young and already so celebrated. Not content with pursuing in seclusion his laborious scientific investigations, he makes a habit of communicating, almost annually, to an audience less restricted than that of the Academy the general result of some of his researches. All the qualities to which Mr. Agassiz has accustomed his listeners were found in the opening prelude; the fullness and freedom of expression which give to his lectures the character of a scientific *causerie;* the dignified

ease of bearing, joined with the simplicity and candor of a savant who teaches neither by aphorisms nor oracles, but who frankly admits the public to the results of his researches; the power of generalization always based upon a patient study of facts, which he knows how to present with remarkable clearness in a language that all can understand. We will not follow the professor in tracing the outlines of his course. Suffice it to say that he intends to show in the general development of the animal kingdom the existence of a definite preconceived plan, successively carried out; in other words, the manifestation of a higher thought, — the thought of God. This creative thought may be studied under three points of view: as shown in the relations which, spite of their manifold diversity, connect all the species now living on the surface of the globe; in their geographical distribution; and in the succession of beings from primitive epochs until the present condition of things."

The summer of 1845 was the last which Agassiz passed at home. It was broken by a short and hurried visit to the glacier of the Aar, respecting which no details have been preserved. He did not then know that

he was taking a final leave of his cabin among the rocks and ice. Affairs connected with the welfare of the institution in Neuchâtel, with which he had been so long connected, still detained him for a part of the winter, and he did not leave for Paris until the first week in March, 1846. His wife and daughters had already preceded him to Germany, where he was to join them again on his way to Paris, and where they were to pass the period of his absence, under the care of his brother-in-law, Mr. Alexander Braun, then living at Carlsruhe. His son was to remain at school at Neuchâtel.

It was two o'clock at night when he left his home of so many years. There had been a general sadness at the thought of his departure, and every testimony of affection and respect accompanied him. The students came in procession with torchlights to give him a parting serenade, and many of his friends and colleagues were also present to bid him farewell. M. Louis Favre says in his Memoir, "Great was the emotion at Neuchâtel when the report was spread abroad that Agassiz was about to leave for a long journey. It is true he promised to come back, but the New World might shower upon him such marvels

that his return could hardly be counted upon. The young people, the students, regretted their beloved professor not only for his scientific attainments, but for his kindly disposition, the charm of his eloquence, the inspiration of his teaching; they regretted also the gay, animated, untiring companion of their excursions, who made them acquainted with nature, and knew so well how to encourage and interest them in their studies."

Pausing at Carlsruhe on his journey, he proceeded thence to Paris, where he was welcomed with the greatest cordiality by scientific men. In recognition of his work on the "Fossil Fishes" the Monthyon Prize of Physiology was awarded him by the Academy. He felt this distinction the more because the bearing of such investigations upon experimental physiology had never before been pointed out, and it showed that he had succeeded in giving a new direction and a more comprehensive character to paleontological research. He passed some months in Paris, busily occupied with the publication of the "Système Glaciaire," his second work on the glacial phenomena. The "Etudes sur les Glaciers" had simply contained a résumé of all the researches undertaken upon the Al-

pine fields of ice and the results obtained up to 1840, inclusive of the author's own work and his wider interpretation of the facts. The "Système Glaciaire" was, on the contrary, an account of a connected plan of investigation during a succession of years, upon a single glacier, with its geodetic and topographic features, its hydrography, its internal structure, its atmospheric conditions, its rate of annual and diurnal progress, and its relations to surrounding glaciers. All the local phenomena, so far as they could be observed, were subjected to a strict scrutiny, and the results corrected by careful comparison, during five seasons. As we have seen, and as Agassiz himself says in his Preface, this band of workers had "lived in the intimacy of the glacier, striving to draw from it the secret of its formation and its annual advance." The work was accompanied by three maps and nine plates. In such a volume of detail there is no room for picturesque description, and little is told of the wonderful scenes they witnessed by day and night, nothing of personal peril and adventure.

This task concluded, he went to England, where he was to spend the few remaining days previous to his departure. Among the

last words of farewell which reached him just as he was leaving the Old World, little thinking then that he was to make a permanent home in America, were these lines from Humboldt, written at Sans Souci: "Be happy in this new undertaking, and preserve for me the first place under the head of friendship in your heart. When you return I shall be here no more, but the king and queen will receive you on this 'historic hill' with the affection which, for so many reasons, you merit. . . .

"Your illegible but much attached friend,

"A. HUMBOLDT."

So closed this period of Agassiz's life. The next was to open in new scenes, under wholly different conditions. He sailed for America in September, 1846.

PART II.

IN AMERICA.

CHAPTER XIII.

1846 : ÆT. 39.

Arrival at Boston. — Previous Correspondence with Charles Lyell and Mr. John A. Lowell concerning Lectures at the Lowell Institute. — Relations with Mr. Lowell. — First Course of Lectures. — Character of Audience. — Home Letter giving an Account of his First Journey in the United States. — Impressions of Scientific Men, Scientific Institutions and Collections.

AGASSIZ arrived in Boston during the first week of October, 1846. He had not come to America without some prospect of employment beside that comprised in his immediate scientific aims. In 1845, when his plans for a journey in the United States began to take definite shape, he had written to ask Lyell whether, notwithstanding his imperfect English, he might not have some chance as a public lecturer, hoping to make in that way additional provision for his scientific expenses

beyond the allowance he was to receive from the King of Prussia. Lyell's answer, written by his wife, was very encouraging.

LONDON, *February* 28, 1845.

. . . My husband thinks your plan of lecturing a very good one, and sure to succeed, for the Americans are fond of that kind of instruction. We remember your English was pleasant, and if you have been practicing since, you have probably gained facility in expression, and a little foreign accent would be no drawback. You might give your lectures in several cities, but he would like very much if you could give a course at the Lowell Institute at Boston, an establishment which pays very highly. . . . In six weeks you might earn enough to pay for a twelve months' tour, besides passing an agreeable time at Boston, where there are several eminent naturalists. . . . As my husband is writing to Mr. Lowell to-morrow upon other matters, he will ask him whether there is any course still open, for he feels sure in that case they would be glad to have you. . . . Mr. Lowell is sole trustee of the Institute, and can nominate whom he pleases. It was very richly endowed for the purpose of lectures by a merchant of Bos-

ton, who died a few years ago. You will get nothing like the same remuneration anywhere else. . . .

Lyell and Mr. Lowell soon arranged all preliminaries, and it was understood that Agassiz should begin his tour in the United States by a course of lectures in Boston before the Lowell Institute. A month or two before sailing he writes as follows to Mr. Lowell.

PARIS, *July* 6, 1846.

. . . Time is pressing, summer is running away, and I feel it a duty to write to you about the contemplated lectures, that you may not be uncertain about them. So far as the subject is concerned, I am quite ready; all the necessary illustrations are also completed, and if I am not mistaken they must by this time be in your hands. . . . I understand from Mr. Lyell that you wish me to lecture in October. For this also I am quite prepared, as I shall, immediately after my arrival in Boston, devote all my time to the consideration of my course. If a later date should suit your plans better, I have no objection to conform to any of your arrangements, as I shall at all events pass the whole winter on the shores of

the Atlantic, and be everywhere in reach of Boston in a very short time. . . . With your approbation, I would give to my course the title of "Lectures on the Plan of the Creation, especially in the Animal Kingdom."

Thus was Agassiz introduced to the institution under whose auspices he first made acquaintance with his American audiences. There he became a familiar presence during more than a quarter of a century. The enthusiastic greeting accorded to him, as a stranger whose reputation had preceded him, ripened with years into an affectionate welcome from friends and fellow-citizens, whenever he appeared on the platform. In the director of the institution, Mr. John A. Lowell, he found a friend upon whose sympathy and wise counsels he relied in all his after years. The cordial reception he met from him and his large family circle made him at once at home in a strange land.

Never was Agassiz's power as a teacher, or the charm of his personal presence more evident than in his first course of Lowell Lectures. He was unfamiliar with the language, to the easy use of which his two or three visits in England, where most of his associates under-

stood and spoke French, had by no means accustomed him. He would often have been painfully embarrassed but for his own simplicity of character. Thinking only of his subject and never of himself, when a critical pause came, he patiently waited for the missing word, and rarely failed to find a phrase which was expressive if not technically correct. He often said afterward that his sole preparation for these lectures consisted in shutting himself up for hours and marshaling his vocabulary, passing in review, that is, all the English words he could recall. As the Lyells had prophesied, his foreign accent rather added a charm to his address, and the pauses in which he seemed to ask the forbearance of the audience, while he sought to translate his thought for them, enlisted their sympathy. Their courtesy never failed him. His skill in drawing with chalk on the blackboard was also a great help both to him and to them. When his English was at fault he could nevertheless explain his meaning by illustrations so graphic that the spoken word was hardly missed. He said of himself that he was no artist, and that his drawing was accurate simply because the object existed in his mind so clearly. However this may be,

it was always pleasant to watch the effect of his drawings on the audience. When showing, for instance, the correspondence of the articulate type, as a whole, with the metamorphoses of the higher insects, he would lead his listeners along the successive phases of insect development, talking as he drew and drawing as he talked, till suddenly the winged creature stood declared upon the blackboard, almost as if it had burst then and there from the chrysalis, and the growing interest of his hearers culminated in a burst of delighted applause.

After the first lecture in Boston there was no doubt of his success. He carried his audience captive. His treatment of the animal kingdom on the broad basis of the comparative method, in which the great types were shown in their relation to each other and to the physical history of the world, was new to his hearers. Agassiz had also the rare gift of divesting his subject of technicalities and superfluous details. His special facts never obscured the comprehensive outline, which they were intended to fill in and illustrate.

This simplicity of form and language was especially adapted to the audience he had now to address, little instructed in the facts or the

nomenclature of science, though characterized by an eager curiosity. A word respecting the quality of the Lowell Institute audience of those days, as new to the European professor as he to them, is in place here. The institution was intended by its founder to fertilize the general mind rather than to instruct the selected few. It was liberally endowed, the entrance was free, and the tickets were drawn by lot. Consequently the working men and women had as good an opportunity for places as their employers. As the remuneration, however, was generous, and the privilege of lecturing there was coveted by literary and scientific men of the first eminence, the instruction was of a high order, and the tickets, not to be had for money, were as much in demand with the more cultivated and even with the fashionable people of the community as with their poorer neighbors. This audience, composed of strongly contrasted elements and based upon purely democratic principles, had, from the first, a marked attraction for Agassiz. A teacher in the widest sense, he sought and found his pupils in every class. But in America for the first time did he come into contact with the general mass of the people on this common ground, and it influenced strongly

his final resolve to remain in this country. Indeed, the secret of his greatest power was to be found in the sympathetic, human side of his character. Out of his broad humanity grew the genial personal influence, by which he awakened the enthusiasm of his audiences for unwonted themes, inspired his students to disinterested services like his own, delighted children in the school-room, and won the cordial interest as well as the coöperation in the higher aims of science, of all classes whether rich or poor.

His first course was to be given in December. Having, therefore, a few weeks to spare, he made a short journey, stopping at New Haven to see the elder Silliman, with whom he had long been in correspondence. Shortly before leaving Europe he had written him, "I can hardly tell you with what pleasure I look forward to seeing you, and making the personal acquaintance of the distinguished savans of your country, whose works I have lately been studying with especial care. There is something captivating in the prodigious activity of the Americans, and the thought of contact with the superior men of your young and glorious republic renews my own youth." Some account of this journey, including his

first impressions of the scientific men as well as the scientific societies and collections of the United States, is given in the following letter. It is addressed to his mother, and with her to a social club of intimate friends and neighbors in Neuchâtel, at whose meetings he had been for years an honored guest.

BOSTON, *December*, 1846.

. . . Having no time to write out a complete account of my journey of last month, I will only transcribe for you some fugitive notes scribbled along the road in stages or railroad carriages. They bear the stamp of hurry and constant interruption.

Leaving Boston the 16th of October, I went by railroad to New Haven, passing through Springfield. The rapidity of the locomotion is frightful to those who are unused to it, but you adapt yourself to the speed, and soon become, like all the rest of the world, impatient of the slightest delay. I well understand that an antipathy for this mode of travel is possible. There is something infernal in the irresistible power of steam, carrying such heavy masses along with the swiftness of lightning. The habits growing out of continued contact with railroads,

and the influence they exert on a portion of the community, are far from agreeable until one is familiar with them. You would cry out in dismay did you see your baggage flung about pell-mell like logs of wood, trunks, chests, traveling-bags, hat-boxes, all in the same mill, and if here and there something goes to pieces no one is astonished; never mind! we go fast, — we gain time, — that is the essential thing.

The manners of the country differ so greatly from ours that it seems to me impossible to form a just estimate regarding them, or, indeed, to pronounce judgment at all upon a population so active and mobile as that of the Northern States of the Union, without having lived among them for a long time. I do not therefore attempt any such estimate. I can only say that the educated Americans are very accessible and very pleasant. They are obliging to the utmost degree; indeed, their cordiality toward strangers exceeds any that I have met elsewhere. I might even add that if I could complain of anything it would be of an excess, rather than a lack, of attention. I have often found it difficult to make it understood that the hotel, where I can work at my ease, suits me better than the proffered hospitality. . . .

But what a country is this! all along the road between Boston and Springfield are ancient moraines and polished rocks. No one who had seen them upon the track of our present glaciers could hesitate as to the real agency by which all these erratic masses, literally covering the country, have been transported. I have had the pleasure of converting already several of the most distinguished American geologists to my way of thinking; among others, Professor Rogers, who will deliver a public lecture upon the subject next Tuesday before a large audience.

A characteristic feature of American life is to be found in the frequent public meetings where addresses are delivered. Shortly after my arrival in Boston I was present at a meeting of some three thousand workmen, foremen of workshops, clerks, and the like. No meeting could have been more respectable and well-conducted. All were neatly dressed; even the simplest laborer had a clean shirt. It was a strange sight to see such an assemblage, brought together for the purpose of forming a library, and listening attentively in perfect quiet for two hours to an address on the advantages of education, of reading, and the means of employing usefully the leisure mo-

ments of a workman's life. The most eminent men vie with each other in instructing and forming the education of the population at large. I have not yet seen a man out of employment or a beggar, except in New York, which is a sink for the emptyings of Europe. Yet do not think that I forget the advantages of our old civilization. Far from it. I feel more than ever the value of a past which belongs to you and in which you have grown up. Generations must pass before America will have the collections of art and science which adorn our cities, or the establishments for public instruction, sanctuaries as it were, consecrated by the devotion of those who give themselves wholly to study. Here all the world works to gain a livelihood or to make a fortune. Few establishments (of learning) are old enough, or have taken sufficiently deep root in the habits of the people, to be safe from innovation; very few institutions offer a combination of studies such as, in its ensemble, meets the demands of modern civilization. All is done by the single efforts of individuals or of corporations, too often guided by the needs of the moment. Thus American science lacks the scope which is characteristic of higher instruction in our old Europe. Objects

of art are curiosities but little appreciated and usually still less understood. On the other hand, the whole population shares in the advanced education provided for all. . . . From Springfield the railroad follows the course of the Connecticut as far as Hartford, turning then directly toward the sea-coast. The valley strikingly resembles that of the Rhine between Carlsruhe and Heidelberg. The same rock, the same aspect of country, and grès bigarré[1] everywhere. The forest reminds one of Odenwald and of Baden-Baden. Nearer the coast are cones of basalt like those of Brissac and the Kaiserstuhl. The erratic phenomena are also very marked in this region; polished rocks everywhere, magnificent furrows on the sandstone and on the basalt, and parallel moraines defining themselves like ramparts upon the plain.

At New Haven I passed several days at the house of Professor Silliman, with whom I have been in correspondence for several years. The University (Yale) owes to the efforts of the Professor a fine collection of minerals and extensive physical and chemical apparatus. Silliman is the patriarch of science in America. For thirty years he has edited

[1] Trias.

an important scientific journal, the channel through which, ever since its foundation, European scientific researches have reached America. . . . One of his sons-in-law, Mr. Shepard,[1] is also chemical professor in the University of South Carolina. Another, Mr. Dana, still a very young man, strikes me as likely to be the most distinguished naturalist of the United States. He was a member of the expedition around the world under the command of Captain Wilkes, and has just published a magnificent volume containing monographs of all the species of polyps and corals, with curious observations on their mode of growth and on the coral islands. I was surprised to find in the collection at New Haven a fine specimen of the great fossil salamander of Oeningen, the " Homo diluvii testis " of Scheuchzer.

From New Haven I went to New York by steamboat. The Sound, between Long Island and the coast of Connecticut, presents a succession of cheerful towns and villages, with single houses scattered over the country, while magnificent trees overhang the sea; we constantly disturbed numbers of aquatic birds which, at our approach, fluttered up around

[1] An error : Mr. Shepard was not the son-in-law of Professor Silliman. — Ed.

the steamer, only to alight farther on. I have never seen such flocks of ducks and gulls.

At New York I hastened to see Auguste Mayor, of whom my uncle will no doubt have given you news, since I wrote to him. Obliged to continue my road in order to join Mr. Gray at Princeton I stopped but one day in New York, the greater part of which I passed with Mr. Redfield, author of a paper on the fossil fishes of Connecticut. His collection, which he has placed at my disposal, has great interest for me; it contains a large number of fossil fishes of different kinds, from a formation in which but one species has been found in Europe. The new red sandstone of Connecticut will also fill a gap in the history of fossil fishes, and this acquisition is so much the more important, because, at the epoch of the grès bigarré, a marked change took place in the anatomical character of fishes. It presents an intermediate type between the primitive fishes of the ancient deposits and the more regular forms of the jurassic deposits.

Mr. Asa Gray, professor of botany at Cambridge, near Boston, had offered to accompany me on my journey to Washington. We were to meet at the house of Professor Tor-

rey, at Princeton, a small town half a day's journey from New York, and the seat of a considerable university, one of the oldest in the United States. The physical department, under the direction of Professor Henry, is remarkably rich in models of machinery and in electrical apparatus, to which the professor especially devotes himself. The museum contains a collection of animals and fossil remains. In the environs of the town, in the ditches, is found a rare kind of turtle, remarkable for the form of the jaws and the length of the tail. I wish very much to procure one, were it only to oblige Professor Johannes Müller, of Berlin, who especially desires one for investigation. But I have failed thus far; the turtles are already withdrawn into their winter quarters. Mr. Torrey promises me some, however, in the spring. It is not easy to get them because their bite is dreaded.

After this I passed four days in Philadelphia. Here, notwithstanding my great desire to see the beautiful country along the shores of the rich bay of Delaware and the banks of the Schuylkill, between which the city lies, I was entirely occupied with the magnificent collections of the Academy of Science and

of the Philosophical Society. The zoölogical collections of the Academy of Science are the oldest in the United States, the only ones, except those of the Wilkes Expedition, which can equal in interest those of Europe. There are the collections of Say, the earliest naturalist of distinction in the United States; there are also the fossil remains and the animals described by Harlan, by Godman, and by Hayes, and the fossils described by Conrad and Morton. Dr. Morton's unique collection of human skulls is also to be found in Philadelphia. Imagine a series of six hundred skulls, mostly Indian, of all the tribes who now inhabit or formerly inhabited America. Nothing like it exists elsewhere. This collection alone is worth a journey to America. Dr. Morton has had the kindness to give me a copy of his great illustrated work representing all the types of his collection. Quite recently a generous citizen of Philadelphia has enriched this museum with the fine collection of birds belonging to the Duke of Rivoli. He bought it for 37,000 francs, and presented it to his native city.

The number of fossil remains comprised in these collections is very considerable; mastodons especially, and fossils of the cretaceous

and jurassic deposits. . . . Imagine that all this is at my full disposal for description and illustration, and you will understand my pleasure. The liberality of the American naturalists toward me is unparalleled.

I must not omit to mention Mr. Lea's collection of fresh-water shells, — a series of the magnificent Unios of the rivers and lakes of America, comprising four hundred species, represented by some thirty specimens of each. Mr. Lea has promised me specimens of all the species. Had I not been bound by an engagement at Washington, and could I have remained three or four days longer in order to label and pack them, I might have taken at once these valuable objects, which will be of great importance in verifying and rectifying the synonyms of European conchologists. After having seen the astonishing variations undergone by these shells in their growth, I am satisfied that all which European naturalists have written on this subject must be revised. Only with the help of a very full series of individuals can one fully understand these animals, and we have only single specimens in our collections. If I had time and means to have drawings made of all these forms, the collection of Mr. Lea would be at

my command for the purpose, and the work would be a very useful one for science.

There are several other private and public collections at Philadelphia, which I have only seen cursorily; that of the Medical School, for instance, and that of the older Peale, who discovered the first mastodon found in the United States, now mounted in his museum. Beside these, there is the collection of Dr. Griffith, rich in skulls from the Gulf of Mexico; that of Mr. Ord, and others. During my stay in Philadelphia, there was also an exhibition of industrial products at the Franklin Institute, where I especially remarked the chemical department. There are no less than three professors of chemistry in Philadelphia, — Mr. Hare, Mr. Booth, and Mr. Frazer. The first is, I think, the best known in Europe.

How a nearer view changes the aspect of things! I thought myself tolerably familiar with all that is doing in science in the United States, but I was far from anticipating so much that is interesting and important. What is wanting to all these men is neither zeal nor knowledge. In both, they seem to compete with us, and in ardor and activity they even surpass most of our savans. What they need

is leisure. I have never felt more forcibly what I owe to the king for enabling me to live for science alone, undisturbed by anxieties and distractions. Here, I do not lose a moment, and when I receive invitations outside the circle of men whom I care particularly to know, I decline, on the ground that I am not free to dispose for my pleasure of time which does not belong to me. For this no one can quarrel with me, and so far as I myself am concerned, it is much better.

I stopped at Baltimore only long enough to see the city. It was Sunday, and as I could make no visits, and was anxious to arrive in good time at Washington, I took advantage of the first train. The capital of the United States is laid out upon a gigantic scale, and, consequently, portions of the different quarters are often to be traced only by isolated houses here and there, — a condition which has caused it to be called the "City of Magnificent Distances." Some of the streets are very handsome, and the capitol itself is really imposing. Their profound veneration for the founder of their liberty and their republic is a noble trait of the American people. The evidences of this are to be seen everywhere. No less than two hundred towns, villages, and

counties bear his name, rather to the inconvenience of the postal administration.

After having visited the capitol and the presidential mansion, and delivered my letters for the Prussian Minister, I went to the Museum of the National Institute. I was impatient to satisfy myself as to the scientific value of the results obtained in the field of my own studies by the voyage of Captain Wilkes around the world, — this voyage having been the object of equally exaggerated praise and criticism. I confess that I was agreeably surprised by the richness of the zoölogical and geological collections; I do not think any European expedition has done more or better; and in some departments, in that of the Crustacea, for example, the collection at Washington surpasses in beauty and number of specimens all that I have seen. It is especially to Dr. Pickering and Mr. Dana that these collections are due. As the expedition did not penetrate to the interior of the continents in tropical regions, the collections of birds and mammals, which fell to the charge of Mr. Peale, are less considerable. Mr. Gray tells me, however, that the botanical collections are very large. More precious, perhaps, than all the collections are the magnificent drawings

of mollusks, zoöphytes, fishes, and reptiles, painted from life by Mr. Drayton. All these plates, to the number of about six hundred, are to be engraved, and indeed are already, in part, executed. I can only compare them to those of the Astrolabe, although they are very superior in variety of position and naturalness of attitude to those of the French Expedition. This is particularly true of the mollusks and fishes. The zoöphytes are to be published; they are admirable in detail. The hydrographic portion and the account of the voyage, edited by Captain Wilkes (unhappily he was absent and I did not see him), has been published for some time, and comprises an enormous mass of information, its chief feature being charts to the number of two hundred. It is amazing; the number of soundings extraordinarily large.[1]

At Washington are also to be seen the headquarters of the Coast Survey, where the fine charts of the coasts and harbors now making under direction of Dr. Bache are executed. These charts are admirably finished. Dr. Bache, the superintendent, was in camp, so

[1] Agassiz subsequently took some part in working up the fish collections from this expedition, but the publication was stopped for want of means to carry it on.

that I could not deliver my letters for him. I saw, however, Colonel Abert, the head of the topographic office, who gave me important information about the West for the very season when I am likely to be there. I am indebted to him also for a series of documents concerning the upper Missouri and Mississippi, California and Oregon, printed by order of the government, and for a collection of fresh-water shells from those regions. I should like to offer him, in return, such sheets of the Federal Map as have appeared. I beg Guyot to send them to me by the first occasion.

As I was due in Boston on an appointed day I was obliged to defer my visit to Richmond, Charleston, and other places in the South. I had, beside, gathered so much material that I had need of a few quiet weeks to consider and digest it all. Returning therefore to Philadelphia, I made there the acquaintance of Mr. Haldeman, author of a monograph on the fresh-water shells of the United States. I had made an appointment to meet him at Philadelphia, being unable to make a detour of fifty leagues in order to visit him at his own home, which is situated beyond the lines of rapid transit. He is a distinguished naturalist, equally well versed in

several branches of our science. He has made me acquainted, also, with a young naturalist from the interior of Pennsylvania, Mr. Baird, professor at Dickinson College, in Carlisle, Pennsylvania, who offered me duplicates from his collections of birds and other animals. In order to avail myself more promptly of this and like acquisitions, I wish that M. Coulon would send me at the close of the winter all that he can procure of the common European birds, of our small mammalia, and some chamois skins, adding also the fish that Charles put aside for me before his departure. It would be safest to send them to the care of Auguste Mayor.

At Philadelphia I separated from my traveling companion, Mr. Gray, who was obliged to return to his home. From Philadelphia, Mr. Haldeman and Mr. Lea accompanied me to Bristol, where Mr. Vanuxem possesses an important collection of fossils from ancient deposits, duplicates of which he promises me. Mr. Vanuxem is one of the official geologists of the State of New York, and author of one of a series of volumes upon the geology of the State, about which I shall presently have something to say. To gain time I took the night train from Bristol to New York, and

arrived at Mayor's at midnight, having written him to expect me.

The next day I visited the market, and in five days I had filled a great barrel with different kinds of fish and fresh-water turtles, beside making several skeletons and various dissections of mollusks. Wishing to employ my time as usefully as possible, I postponed my visits to the savans of the city, and the delivery of my letters, till I was on the eve of departure, that I might avoid all invitations. I had especial pleasure in making the acquaintance of the two Le Contes, father and son, who own the finest collection of insects in the United States. I can easily make some thousand exchanges with them when I receive those that M. Coulon has put aside for me, with a view to exchange. . . . Every morning Auguste Mayor went with me to the market before going to his office and helped me to carry my basket when it was too heavy. One day I brought back no less than twenty-four turtles, taken in one draught of the net. I made four skeletons, and dissected several others. Under such conditions the day ought to have thirty-six working hours.

Were I an artist, instead of describing my voyage from New York to Albany, I would

draw you a panorama of the shores of the Hudson. I know nothing except the banks of the Rhine to compare with those of this magnificent river. The resemblance between them is striking; the sites, the nature of the rocks, the appearance of the towns and villages, the form of the Albany bridges, even the look of the inhabitants, of whom the greater number are of Dutch or German origin, — all are similar.

I stopped at West Point to make the acquaintance of Professor Bailey of the Military School there. I already knew him by reputation. He is the author of very detailed and interesting researches upon the microscopic animalcules of America. I had a pamphlet to deliver to him from Ehrenberg, who has received from him a great deal of material for his large work on fossil Infusoria. I spent three most delightful days with him, passed chiefly in examining his collections, from which he gave me many specimens. We also made several excursions in the neighborhood, in order to study the erratic phenomena and the traces of glaciers, which everywhere cover the surface of the country. Polished rocks, as distinct as possible; moraines continuous over large spaces; stratified drift, as on

the borders of the glacier of Grindelwald; in short, all the usual accompaniments of the glaciers are there, and one may follow the "roches moutonnées" with the eye to a great distance.

Albany is the seat of government of the State of New York. It has a medical school, an agricultural society, a geological museum, an anatomical museum, and a museum of natural history. The government has just completed the publication of a work, unique of its kind, a natural history of the State in sixteen volumes, quarto, with plates; twenty-five hundred copies have been printed, only five hundred of which are for sale, the rest being distributed throughout the State. Four volumes are devoted to geology and mining alone, the others to zoölogy, botany, and agriculture. Yes, twenty-five hundred copies of a work in sixteen volumes, quarto, scattered throughout the State of New York alone! When I think that I began my studies in natural history by copying hundreds of pages from a Lamarck which some one had lent me, and that to-day there is a State in which the smallest farmer may have access to a costly work, worth a library to him in itself, I bless the efforts of those who devote themselves to public instruc-

tion. . . . I have not neglected the opportunity offered by the North River (the Hudson) for the study of the fresh-water fishes of this country. I have filled a barrel with them. The species differ greatly from ours, with the exception of the perch, the eel, the pike, and the sucker, in which only a practiced eye could detect the difference; all the rest belong to genera unknown in Europe, or, at least, in Switzerland. . . .

I was fortunate enough to procure also, in the few days of my stay, all the species taken in the lakes and rivers around Albany. Several others have been given me from Lake Superior. Since my return to Boston I have been collecting birds and comparing them with those of Europe. If M. Coulon could obtain for me a collection of European eggs, even the most common, I could exchange them for an admirable series of the native species here. I have also procured several interesting mammals; among others, two species of hares different from those I brought from Halifax, striped squirrels, etc.

I will tell you another time something of the collections of Boston and Cambridge, the only ones in the United States which can rival those of Philadelphia. To-day I have made

my first attempt at lecturing. Of that, also, I will tell you more in my next letter, when I know how it has been liked. It is no small matter to satisfy an audience of three thousand people in a language with which you are but little familiar. . . .

CHAPTER XIV.

1846–1847: ÆT. 39–40.

Course of Lectures in Boston on Glaciers. — Correspondence with Scientific Friends in Europe. — House in East Boston. — Household and Housekeeping. — Illness. — Letter to Elie de Beaumont. — Letter to James D. Dana.

THE course at the Lowell Institute was immediately followed by one upon glaciers, the success of which was guaranteed by private subscription, — an unnecessary security, since the audience, attracted by the novelty and picturesqueness of the subject, as well as by the charm of presentation and fullness of illustration, was large and enthusiastic.

Agassiz was evidently encouraged himself by his success, for toward the close of his Lowell Lectures he writes as follows: —

TO CHANCELLOR FAVARGEZ.

BOSTON, *December* 31, 1846.

. . . Beside my lecture course, now within a few days of its conclusion, and the ever-increasing work which grows on my hands in

proportion as I become familiar with the environs of Boston, where I shall still remain a few weeks longer, I have so much to do in keeping up my journals, notes, and observations that I have not found a moment to write you since the last steamer. . . . Never did the future look brighter to me than now. If I could for a moment forget that I have a scientific mission to fulfill, to which I will never prove recreant, I could easily make more than enough by lectures which would be admirably paid and are urged upon me, to put me completely at my ease hereafter. But I will limit myself to what I need in order to repay those who have helped me through a difficult crisis, and that I can do without even turning aside from my researches. Beyond that all must go again to science, — there lies my true mission. I rejoice in what I have been able to do thus far, and I hope that at Berlin they will be satisfied with the results which I shall submit to competent judges on my return. If I only have time to finish what I have begun! You know my plans are not wont to be too closely restricted.

Why do you not write to me? Am I then wholly forgotten in your pleasant circle while my thoughts are every day constantly with my Neuchâtel friends? . . .

Midnight, January 1st. A happy new year to you and to all members of the Tuesday Club. Bonjour et bon an. . . .

Some portions of Agassiz's correspondence with his European friends and colleagues during the winter and summer of 1847 give a clew to the occupations and interests of his new life, and keep up the thread of the old one.

LOUIS AGASSIZ TO M. DECAISNE.

February, 1847.

. . . I write only to thank you for the pleasure your note gave me. When one is far away, as I am, from everything belonging to one's past life, the merest sign of friendly remembrance is a boon. Do not infer from this that America does not please me. On the contrary, I am delighted with my stay here, although I do not quite understand all that surrounds me; or I should perhaps rather say that many principles which, theoretically, we have been wont to think perfect in themselves, seem in their application to involve results quite contrary to our expectations. I am constantly asking myself which is better, — our old Europe, where the man of exceptional gifts can give himself absolutely

to study, opening thus a wider horizon for the human mind, while at his side thousands barely vegetate in degradation or at least in destitution; or this new world, where the institutions tend to keep all on one level as part of the general mass, — but a mass, be it said, which has no noxious elements. Yes, the mass here is decidedly good. All the world lives well, is decently clad, learns something, is awake and interested. Instruction does not, as in some parts of Germany for instance, furnish a man with an intellectual tool and then deny him the free use of it. The strength of America lies in the prodigious number of individuals who think and work at the same time. It is a severe test of pretentious mediocrity, but I fear it may also efface originality. . . . You are right in believing that one works, or at least that one *can* work, better in Paris than elsewhere, and I should esteem myself happy if I had my nest there, but who will make it for me? I am myself incapable of making efforts for anything but my work. . . .

AGASSIZ TO MILNE EDWARDS.

May 31, 1847.

. . . After six weeks of an illness which has rendered me unfit for serious work I long to be transported into the circle of my Paris friends, to find myself again among the men whose devotion to science gives them a clear understanding of its tendency and influence. Therefore I take my way quite naturally to the Rue Cuvier and mount your stairs, confident that there I shall find this chosen society. Question upon question greets me regarding this new world, on the shore of which I have but just landed, and yet about which I have so much to say that I fear to tire my listeners.

Naturalist as I am, I cannot but put the people first, — the people who have opened this part of the American continent to European civilization. What a people! But to understand them you must live among them. Our education, the principles of our society, the motives of our actions, differ so greatly from what I see here, that I should try in vain to give you an idea of this great nation, passing from childhood to maturity with the faults of spoiled children, and yet with the

nobility of character and the enthusiasm of youth. Their look is wholly turned toward the future; their social life is not yet irrevocably bound to exacting antecedents, and thus nothing holds them back, unless, perhaps, a consideration for the opinion in which they may be held in Europe. This deference toward England (unhappily, to them, Europe means almost exclusively England) is a curious fact in the life of the American people. They know us but little, even after having made a tour in France, or Italy, or Germany. From England they receive their literature, and the scientific work of central Europe reaches them through English channels. . . . Notwithstanding this kind of dependence upon England, in which American savans have voluntarily placed themselves, I have formed a high opinion of their acquirements, since I have learned to know them better, and I think we should render a real service to them and to science, by freeing them from this tutelage, raising them in their own eyes, and drawing them also a little more toward ourselves. Do not think that these remarks are prompted by the least antagonism toward English savans, whom no one more than myself has reason to regard with affection and esteem. But since

these men are so worthy to soar on their own wings, why not help them to take flight? They need only confidence, and some special recognition from Europe would tend to give them this. . . .

Among the zoölogists of this country I would place Mr. Dana at the head. He is still very young, fertile in ideas, rich in facts, equally able as geologist and mineralogist. When his work on corals is completed, you can better judge of him. One of these days you will make him a correspondent of the Institute, unless he kills himself with work too early, or is led away by his tendency to generalization. Then there is Gould, author of the malacologic fauna of Massachusetts, and who is now working up the mollusks of the Wilkes Expedition. De Kay and Lea, whose works have long been known, are rather specialists, I should say. I do not yet know Holbrook personally. Pickering, of the Wilkes Expedition, is a well of science, perhaps the most erudite naturalist here. Haldeman knows the fresh-water gasteropods of this country admirably well, and has published a work upon them. Le Conte is a critical entomologist who seems to me thoroughly familiar with what is doing in Europe. In connection with Halde-

man he is working up the articulates of the Wilkes Expedition. Wyman, recently made professor at Cambridge, is an excellent comparative anatomist, and the author of several papers on the organization of fishes. . . . The botanists are less numerous, but Asa Gray and Dr. Torrey are known wherever the study of botany is pursued. Gray, with his indefatigable zeal, will gain upon his competitors. . . . The geologists and mineralogists form the most numerous class among the savans of the country. The fact that every state has its corps of official geologists has tended to develop study in this direction to the detriment of other branches, and will later, I fear, tend to the detriment of science itself; for the utilitarian tendency thus impressed on the work of American geologists will retard their progress. With us, on the contrary, researches of this kind constantly tend to assume a more and more scientific character. Still, the body of American geologists forms, as a whole, a most respectable contingent. The names of Charles T. Jackson, James Hall, Hitchcock, Henry and William Rogers (two brothers), have long been familiar to European science. After the geologists, I would mention Dr. Morton, of Philadelphia, well known as the author of sev-

eral papers upon fossils, and still better by his great work upon the indigenous races of America. He is a man of science in the best sense; admirable both as regards his knowledge and his activity. He is the pillar of the Philadelphia Academy.

The chemists and physicists, again, form another utilitarian class of men in this country. As with many of them purely scientific work is not their sole object, it is difficult for an outsider to distinguish between the clever manipulators and those who have higher aims. . . .

The mathematicians have also their *culte*, dating back to Bowditch, the translator of the "Mécanique céleste," and the author of a work on practical navigation. He died in Boston, where they are now erecting a magnificent monument to his memory. Mr. Peirce, professor at Cambridge, is considered here the equal of our great mathematicians. It is not for me, who cannot do a sum in addition, to pretend to a judgment in the matter.[1]

You are familiar, no doubt, with the works of Captain Wilkes and the report of his jour-

[1] Though Agassiz was no mathematician, and Peirce no naturalist, they soon found that their intellectual aims were the same, and they became very close friends.

ney around the world. His charts are much praised. The charts of the coasts and harbors of the United States, made under the direction of Dr. Bache and published at government expense, are admirable. The reports of Captain Frémont concerning his travels are also most interesting and instructive; to botanists especially so, on account of the scientific notes accompanying them.

I will not speak at length of my own work, — my letter is already too long. During the winter I have been chiefly occupied in making collections of fishes and birds, and also of the various woods. The forests here differ greatly from ours in the same latitude. I have even observed that they resemble astonishingly the forests of the Molasse epoch, and the analogy is heightened by that between the animals of this country and those of the eastern coasts of Asia as compared with those of the Molasse, such as the chelydras, andreas, etc. I will send a report upon this to M. Brongniart as soon as I have the time to prepare it. On the erratic phenomena, also, I have made numerous observations, which I am anxious to send to M. de Beaumont. These phenomena, so difficult of explanation with us, become still more complicated here,

both on account of their contact with the sea and of the vast stretches of flat country over which they extend.

For the last few days I have been especially occupied with the development of the medusæ. In studying the actiniæ I have made a striking discovery, and I should be glad if you would communicate it to the Academy in advance of the illustrated paper on the same subject, which I hope soon to send you. Notwithstanding their star-like appearance, the star-fishes have, like the sea-urchins, indications by no means doubtful, of a symmetrical disposition of their organs in pairs, and an anterior and posterior extremity easily recognized by the special form of their oral opening. I have now satisfied myself that the madrepores have something analogous to this in the arrangement of their partitions, so that I am tempted to believe that this tendency to a symmetrical arrangement of parts in pairs, is a general character of polyps, disguised by their radiating form. Among the medusæ something similar exists in the disposition of the marginal appendages and the ocelli. I attach the more importance to these observations, because they may lead to a clearer perception than we have yet reached

of the natural relations between the radiates and the other great types of the animal kingdom.

This summer I hope to explore the lower lakes of Canada, and also the regions lying to the eastward as far as Nova Scotia; in the autumn I shall resume my excursions on the coast and in the Alleghanies, and shall pass a part of the winter in the Carolinas. I will soon write to Monsieur Brongniart concerning my plans for next year. If the Museum were desirous to aid me in my undertakings, I should like to make a journey of exploration next summer in a zone thus far completely neglected by naturalists, the region, namely, of the small lakes to the west of Lake Superior, where the Mississippi takes its rise, and also of that lying between this great basin of fresh water and the southern arm of Hudson Bay. I would employ the autumn in exploring the great valley of the Mississippi, and would pass the winter on the borders of the Gulf of Mexico.

To carry out such projects, however, I have need of larger resources than I can create by my own efforts, and I shall soon be at the end of the subsidy granted me by the King of Prussia. I shall, however, subordinate all

these projects to the possibilities of which you kindly tell me. Notwithstanding the interest offered by the exploration of a country so rich as this, notwithstanding the gratifying welcome I have received here, I feel, after all, that nowhere can one work better than in our old Europe, and the friendship you have shown me is a more than sufficient motive, impelling me to return as soon as possible to Paris. Remember me to our common friends. I have made some sufficiently interesting collections which I shall forward to the Museum; they will show you that I have done my best to fulfill my promises, forgetting no one. . . .

In the summer of 1847 Agassiz established himself in a small house at East Boston, sufficiently near the sea to be a convenient station for marine collections. Here certain members of his old working corps assembled about him, and it soon became, like every place he had ever inhabited, a hive of industry. Chief among his companions were Count François de Pourtalès, who had accompanied him to this country; Mr. E. Desor, who soon followed him to America; and Mr. Jaques Burkhardt, who had preceded them all, and

was now draughtsman in chief to the whole party. To his labors were soon added those of Mr. A. Sonrel, the able lithographic artist, who illustrated the most important works subsequently published by Agassiz. To an exquisite skill in his art he added a quick, intelligent perception of structural features from the naturalist's point of view, which made his work doubly valuable. Besides those abovementioned, there were several assistants who shared the scientific work in one department or another.

It must be confessed that this rather original establishment had the aspect of a laboratory rather than a home, domestic comfort being subordinate to scientific convenience. Every room served in some sort the purposes of an aquarium or a studio, while garret and cellar were devoted to collections. The rules of the household were sufficiently elastic to suit the most erratic student. A sliding scale for meals allowed the greatest freedom for excursions along the neighboring shores and beaches, and punctuality in work was the only punctuality demanded.

Agassiz himself was necessarily often absent, for the maintenance of the little colony depended in great degree upon his exertions.

During the winter of 1847, while continuing his lectures in Boston and its vicinity, he lectured in other places also. It is difficult to track his course at this time; but during the winters of 1847 and 1848 he lectured in all the large eastern cities, New York, Albany, Philadelphia, and Charleston, S. C. Everywhere he drew large crowds, and in those days his courses of lectures were rarely allowed to close without some public expression of gratitude and appreciation from the listeners. Among his papers are preserved several sets of resolutions from medical and scientific societies, from classes of students, and from miscellaneous audiences, attesting the enthusiasm awakened by his instruction. What he earned in this way enabled him to carry on his work and support his assistants. Still, the strain upon his strength, combined with all that he was doing beside in purely scientific work, was severe, and before the twelvemonth was out he was seriously ill. At this time Dr. B. E. Cotting, a physician whose position as curator of the Lowell Institute had brought him into contact with Agassiz, took him home to his house in the country, where he tended him through some weeks of tedious illness, hastening his convalescence by excur-

sions in all the neighboring country, from which they returned laden with specimens, — plants, birds, etc. In this hospitable home he passed his fortieth birthday, the first in this country. His host found him standing thoughtful and abstracted by the window. "Why so sad?" he asked. "That I am so old, and have done so little," was the answer.

After a few weeks he was able to return to his work, and the next letter gives some idea of his observations, especially upon the traces of glacial action in the immediate vicinity of Boston and upon the shores of Massachusetts Bay. Indeed, he never lost sight of these features, which had caught his attention the moment he landed on the continent. In one of his later lectures he gives a striking account of this first impression.

"In the autumn of 1846," he says, "six years after my visit to Great Britain in search of glaciers, I sailed for America. When the steamer stopped at Halifax, eager to set foot on the new continent so full of promise for me, I sprang on shore and started at a brisk pace for the heights above the landing. On the first undisturbed ground, after leaving the town, I was met by the familiar signs, the polished surfaces, the furrows and scratches,

the *line engraving*, so well known in the Old World; and I became convinced of what I had already anticipated as the logical sequence of my previous investigations, that here also this great agent had been at work." The incident seems a very natural introduction to the following letter, written a few months later:—

TO ELIE DE BEAUMONT.

BOSTON, *August* 31, 1847.

. . . I have waited to write until I should have some facts sufficiently important to claim your attention. In truth, the study of the marine animals, which I am, for the first time, able to observe in their natural conditions of existence, has engrossed me almost exclusively since I came to the United States, and only incidentally, as it were, I have turned my attention to paleontology and geology. I must, however, except the glacial phenomena, a problem, the solution of which always interests me deeply. This great question, far from presenting itself more simply here, is complicated by peculiarities never brought to my notice in Europe. Happily for me, Mr. Desor, who had been in Scandinavia before joining me here, called my at-

tention at once to certain points of resemblance between the phenomena there and those which I had seen in the neighborhood of Boston. Since then, we have made several excursions together, have visited Niagara, and, in short, have tried to collect all the special facts of glacial phenomena in America. . . . You are, no doubt, aware that the whole rocky surface of the ground here is polished. I do not think that anywhere in the world there exist polished and rounded rocks in better preservation or on a larger scale. Here, as elsewhere, erratic débris are scattered over these surfaces, scratched pebbles impacted in mud, forming unstratified masses mixed with and covered by large erratic boulders, more or less furrowed or scratched, the upper ones being usually angular and without marks. The absence of moraines, properly so-called, in a country so little broken, is not surprising; I have, however, seen very distinct ones in some valleys of the White Mountains and in Vermont. Up to this time there had been nothing very new in the aspect of the phenomena as a whole; but on examining attentively the internal arrangement of all these materials, especially in the neighborhood of the sea, one

soon becomes convinced that the ocean has partially covered and more or less remodeled them. In certain places there are patches of stratified sand interposed between masses of glacial drift-deposit; elsewhere, banks of sand and pebbles crown the irregularities of the glacial deposit, or fill in its depressions; in other localities the glacial pebbles may be washed and completely cleared of mud, retaining, however, their markings; or again, these markings may have disappeared, and the material is arranged in lines or ramparts, as it were, of diverse conformation, in which Mr. Desor recognized all the modifications of the "œsars" of Scandinavia. The disposition of the œsars, as seen here, is evidently due entirely to the action of the waves, and their frequency along the coast is a proof of this. In a late excursion with Captain Davis on board a government vessel I learned to understand the mode of formation of the submarine dikes bordering the coast at various distances, which would be œsars were they elevated; with the aid of the dredge I satisfied myself of their identity. With these facts before me I cannot doubt that the œsars of the United States consist essentially of glacial material remodeled by the sea; while

farther inland, though here and there reaching the sea-coast, we have unchanged glacial drift deposit. At some points the alteration is so slight as to denote only a momentary rise of the sea. Under these circumstances one would naturally look for fossils in the drift, and M. Desor, in company with M. de Pourtalès, was the first to find them, at Brooklyn, in Long Island, which lies to the south of New York. They were imbedded in a glacial clay deposit, having all the ordinary character of such deposits, with only slight traces of stratified sand. It is true that the greater number of these fossils (all belonging to species now living on the coast) were broken into angular fragments, not excepting even the thick tests of the Venus mercenaria. . . .

The suburb of Boston where I am living (East Boston) is built on an island, one kilometer and a half long, extending from north to southeast, and varying in width at different points from two to six or seven hundred metres. Its height above the sea-level is about sixty feet. This little island is composed entirely of glacial muddy deposit, containing scratched pebbles mixed with larger boulders or blocks, and covered also with a considerable number of boulders of divers

forms and dimensions. At East Boston you cannot see what underlies this deposit; but no doubt it rests upon a rounded mass of granite, polished and grooved like several others in Boston harbor. . . .

In our journey to Niagara, Mr. Desor and I assured ourselves that the river deposits, in which, among other things, the mastodon is found with the fresh-water shells of Goat Island, are posterior to the drift. It is a fact worth consideration that the mastodons found in Europe are buried in true tertiary formations, while the great mastodon of the United States is certainly posterior to the drift. . . . In another letter I will tell you something of my observations upon the geographical distribution of marine animals at different depths and on different bottoms, and also upon the relations between this distribution and that of the fossils in the tertiary deposits.[1] . . .

Although so deeply interested by the geological features of the country, Agassiz was nevertheless drawn even more strongly to the

[1] I have left out a portion of this letter which appeared in the first edition of the book, because I learned that the facts there given concerning the deposit of Zostera marina were not substantiated, and that Agassiz consequently did not forward the letter in its first form. The remainder of this chapter appears in this edition for the first time. — E. C. A.

study of the marine animals for which his position on the sea-coast gave him such opportunities as he had never before had. The next letter shows how fully his time was occupied, and how fascinating this new field of observation was to him. The English is still a little foreign. He was not yet quite at home in the language which he afterward wrote and spoke with such fluency.

TO JAMES D. DANA.

EAST BOSTON, *September*, 1847.

. . . What have you thought of me all this time, not having written a single line neither to you nor to Professor Silliman after the kind reception I have met with by your whole family? Pray excuse me and consider, if you please, the difficulty under which I labor, having every day to look after hundreds of new things which always carry me beyond usual hours of working, when I am then so much tired that I can think of nothing. Nevertheless, it is a delightful life to be allowed to examine in a fresh state so many things of which I had but an imperfect knowledge from books. The Boston market supplies me with more than I can examine.

Since I had the pleasure of seeing you I

have been very successful in collecting specimens, especially in New York and Albany. In Washington I have been delighted to see the collections of the Exploring Expedition. They entitle you to the highest thanks from all scientific naturalists, and I hope it will be also felt in the same manner by your countrymen at large. . . . I long for the opportunity of studying your fossil shells. As soon as I have gone over my Lowell lectures I hope to be able to move. I shall only pack up what I have already collected; but I cannot yet tell you precisely the time.

I began studying your "Zoöphytes," but it is so rich a book that I proceed slowly. For years I have not learned so much from a book as from yours. As I soon saw I would not be able to go through in a short time, I sent a short preliminary report to one of our most widely diffused papers, "Preussische Staats Zeitung," giving only the general impression of your work, and I shall send to Erichson a fuller scientific report after I have done with the whole volume.

As I happen to have a lithograph of the original specimen of the Homo deluvii testis of Scheuchzer, I will forward it to Professor Silliman with this letter. I expect you will

find it the counterpart of the specimen in your museum; or very nearly in the same state of preservation.

Having just lately received my books, I also inclose a pamphlet from Ehrenberg, which he desired me to leave with you, and also the books Professor Silliman has had the kindness to lend me. . . . I have made many observations which I wish to publish, but I can find no time to write them for you now. I must wait till the weather is so dull as to bring nothing into the hands of gunners and fishermen. . . .

So closed his first year in America. The second unfolded events both in the home he had left and in the one to which he had unconsciously come, which were to shape his future career, and exert the most powerful influence upon his whole life.

CHAPTER XV.

1847 – 1850 : ÆT. 40 – 43.

Excursions on Coast Survey Steamer. — Relations with Dr. Bache, the Superintendent of the Coast Survey. — Political Disturbances in Switzerland. — Change of Relations with Prussia. — Scientific School established in Cambridge. — Chair of Natural History offered to Agassiz. — Acceptance. — Removal to Cambridge. — Literary and Scientific Associations there and in Boston. — Household in Cambridge. — Beginning of Museum. — Journey to Lake Superior. — "Report, with Narration." — "Principles of Zoölogy," by Agassiz and Gould. — Letters from European Friends respecting these Publications. — Letter from Hugh Miller. — Second Marriage. — Arrival of his Children in America.

One of Agassiz's great pleasures in the summer of 1847 consisted in excursions on board the Coast Survey steamer Bibb, then employed in the survey of the harbor and bay of Boston, under command of Captain (afterward Admiral) Charles Henry Davis. Under no more kindly auspices could Agassiz's relations with this department of government work have been begun. "My cabin," writes Captain Davis, after their first trip together, "seems lonely without you."

Hitherto the sea-shore had been a closed book to the Swiss naturalist, and now it opened to him a field of research almost as stimulating as his own glaciers. Born and bred among the mountains, he knew marine animals only as they can be known in dried and alcoholic specimens, or in a fossil state. From the Bibb he writes to a friend on shore: "I learn more here in a day than in months from books or dried specimens. Captain Davis is kindness itself. Everything I can wish for is at my disposal so far as it is possible."

Dr. Bache was at this time Superintendent of the Coast Survey, and he saw at once how the work of the naturalist might ally itself with the professional work of the Survey to the greater usefulness of both. From the beginning to the end of his American life, therefore, the hospitalities of the United States Coast Survey were open to Agassiz. As a guest on board her vessels he studied the reefs of Florida and the Bahama Banks, as well as the formations of our New England shores. From the deck of the Bibb, in connection with Count de Pourtalès, his first dredging experiments were undertaken; and his last long voyage around the continent, from Boston to San Francisco, was made on board the Hassler, a

Coast Survey vessel fitted out for the Pacific shore. Here was another determining motive for his stay in this country. Under no other government, perhaps, could he have had opportunities so invaluable to a naturalist.

But events were now passing in Europe which made his former position there, as well as that of many of his old friends, wholly unstable. In February, 1848, the proclamation of the French republic broke upon Europe like a clap of thunder from a clear sky. The news created great disturbances in Switzerland, and especially in the canton of Neuchâtel, where a military force was immediately organized by the republican party in opposition to the conservatives, who would fain have continued loyal to the Prussian king. For the moment all was chaos, and the prospects of institutions of learning were seriously endangered. The republican party carried the day; the canton of Neuchâtel ceased to be a dependence of the Prussian monarchy, and became merged in the general confederation of Switzerland.

At about the same time that Agassiz, in consequence of this change of conditions, was honorably discharged from the service of the Prussian king, a scientific school was organ-

ized at Cambridge, Massachusetts, in direct connection with Harvard University. This school, known as the Lawrence Scientific School, owed its existence to the generosity of Abbott Lawrence, formerly United States Minister at the Court of St. James. He immediately offered the chair of Natural History (Zoölogy and Geology) to Agassiz, with a salary of fifteen hundred dollars, guaranteed by Mr. Lawrence himself, until such time as the fees of the students should be worth three thousand dollars to their professor. This time never came. Agassiz's lectures, with the exception of the more technical ones addressed to small classes, were always fully attended, but special students were naturally very few in a department of pure science, and their fees never raised the salary of the professor perceptibly. This was, however, counterbalanced in some degree by the clause in his contract which allowed him entire freedom for lectures elsewhere, so that he could supplement his restricted income from other sources.

In accordance with this new position Agassiz now removed his bachelor household to Cambridge, where he opened his first course in April, 1848. He could hardly have come to Harvard at a more auspicious moment, so

far as his social and personal relations were concerned. The college was then on a smaller scale than now, but upon its list of professors were names which would have given distinction to any university. In letters, there were Longfellow and Lowell, and Felton, the genial Greek scholar, of whom Longfellow himself wrote, "In Attica thy birthplace should have been." In science, there were Peirce, the mathematician, and Dr. Asa Gray, then just installed at the Botanical Garden, and Jeffries Wyman, the comparative anatomist, appointed at about the same time with Agassiz himself. To these we might almost add, as influencing the scientific character of Harvard, Dr. Bache, the Superintendent of the Coast Survey, and Charles Henry Davis, the head of the Nautical Almanac, since the kindly presence of the former was constantly invoked as friend and counselor in the scientific departments, while the latter had his residence in Cambridge, and was as intimately associated with the interests of Harvard as if he had been officially connected with the university.

A more agreeable set of men, or one more united by personal relations and intellectual aims, it would have been difficult to find. In connection with these names, those of Prescott,

Ticknor, Motley, and Holmes also arise most naturally, for the literary men and scholars of Cambridge and Boston were closely united; and if Emerson, in his country home at Concord, was a little more withdrawn, his influence was powerful in the intellectual life of the whole community, and acquaintance readily grew to friendship between him and Agassiz. Such was the pleasant and cultivated circle into which Agassiz was welcomed in the two cities, which became almost equally his home, and where the friendships he made gradually transformed exile into household life and ties.

In Cambridge he soon took his share in giving as well as receiving hospitalities, and his Saturday evenings were not the less attractive because of the foreign character and somewhat unwonted combination of the household. Over its domestic comforts now presided an old Swiss clergyman, Monsieur Christinat. He had been attached to Agassiz from childhood, had taken the deepest interest in his whole career, and, as we have seen, had assisted him to complete his earlier studies. Now, under the disturbed condition of things at home, he had thrown in his lot with him in America. "If your old friend," he writes, "can live

with his son Louis, it will be the height of his happiness." To Agassiz his presence in the house was a benediction. He looked after the expenses, and acted as commissary in chief to the colony. Obliged, as Agassiz was, frequently to be absent on lecturing tours, he could, with perfect security, intrust the charge of everything connected with the household to his old friend, from whom he was always sure of an affectionate welcome on his return. In short, so far as an old man could, "papa Christinat," as he was universally called in this miscellaneous family, strove to make good to him the absence of wife and children.

The make-up of the settlement was somewhat anomalous. The house, though not large, was sufficiently roomy, and soon after Agassiz was established there he had the pleasure of receiving under his roof certain friends and former colleagues, driven from their moorings in Europe by the same disturbances which had prevented him from returning there. The arrival among them of Mr. Guyot, with whom his personal and scientific intimacy was of such long standing, was a great happiness. It was especially a blessing at this time, for troubles at home weighed upon Agassiz and depressed him. His wife,

always delicate in health, had died, and although his children were most affectionately provided for in her family and his own, they were separated from each other, as well as from him; nor did he think it wise to bring them while so young, to America. The presence, therefore, of one who was almost like a brother in sympathy and companionship, was now more than welcome. His original staff of co-workers and assistants still continued with him, and there were frequent guests besides, chiefly foreigners, who, on arriving in a new country, found their first anchorage and point of departure in this little European settlement.

The house stood in a small plot of ground, the cultivation of which was the delight of papa Christinat. It soon became a miniature zoölogical garden, where all sorts of experiments in breeding and observations on the habits of animals, were carried on. A tank for turtles and a small alligator in one corner, a large hutch for rabbits in another, a cage for eagles against the wall, a tame bear and a family of opossums, made up the menagerie, varied from time to time by new arrivals.

But Agassiz could not be long in any place without beginning to form a museum. When

he accepted the chair offered him at Cambridge, there were neither collections nor laboratories belonging to his department. The specimens indispensable to his lectures were gathered almost by the day, and his outfit, with the exception of the illustrations he had brought from Europe, consisted of a blackboard and a lecture-room. There was no money for the necessary objects, and the want of it had to be supplied by the professor's own industry and resources. On the banks of the Charles River, just where it is crossed by Brighton Bridge, was an old wooden shanty set on piles; it might have served perhaps, at some time, as a bathing or a boat house. The use of this was allowed Agassiz for the storing of such collections as he had brought together. Pine shelves nailed against the walls served for cases, and with a table or two for dissection this rough shelter was made to do duty as a kind of laboratory. The fact is worth noting, for here was the beginning of the Museum of Comparative Zoölogy in Cambridge, now admitted to a place among the great institutions of its kind in the world.

In the summer of 1848 Agassiz organized an expedition entirely after his own heart, in-

asmuch as it combined education with observation in the field. The younger portion of the party consisted of several of his special pupils, and a few other Harvard students who joined the expedition from general interest. Beside these, there were several volunteer members, who were either naturalists or had been attracted to the undertaking by their love of nature and travel. Their object was the examination of the eastern and northern shores of Lake Superior from Sault Ste. Marie to Fort William, a region then little known to science or to tourists. Agassiz taught along the road. At evening, around the camp-fire, or when delayed by weather or untoward circumstances, he would give to his companions short and informal lectures, it might be on the forest about them, or on the erratic phenomena in the immediate neighborhood, — on the terraces of the lake shore, or on the fish of its waters. His lecture-room, in short, was everywhere; his apparatus a traveling blackboard and a bit of chalk; while his illustrations and specimens lay all around him, wherever the party chanced to be.

To Agassiz himself the expedition was of the deepest interest. Glacial phenomena had, as we have seen, met him at every turn since

his arrival in the United States, but nowhere had he found them in greater distinctness than on the shores of Lake Superior. As the evidence accumulated about him, he became more than ever satisfied that the power which had modeled and grooved the rocks all over the country, and clothed it with a sheet of loose material reaching to the sea, must have been the same which had left like traces in Europe. In a continent of wide plains and unbroken surfaces, and, therefore, with few centres of glacial action, the phenomena were more widely and uniformly scattered than in Europe. But their special details, down to the closest minutiæ, were the same, while their definite circumscription and evenness of distribution forbade the idea of currents or floods as the moving cause. Here, as elsewhere, Agassiz recognized at once the comprehensive scope of the phenomena. The whole history reconstructed itself in his mind, to the time when a sheet of ice clothed the land, reaching the Atlantic sea-board, as it now does the coast of Spitzbergen and the Arctic shores.

He made also a careful survey of the local geology of Lake Superior, and especially of the system of dykes, by the action of which

he found that its bed had been excavated, and the outline of its shores determined. But perhaps the inhabitants of the lake itself occupied him even more than its conformation or its surrounding features. Not only for its own novelty and variety, but for its bearing on the geographical distribution of animals, the fauna of this great sheet of fresh water interested him deeply. On this journey he saw at Niagara for the first time a living gar-pike, the only representative among modern fishes of the fossil type of Lepidosteus. From this type he had learned more perhaps than from any other, of the relations between the past and the present fishes. When a student of nineteen years of age, his first sight of a stuffed skin of a gar-pike in the Museum of Carlsruhe told him that it stood alone among living fishes. Its true alliance with the Lepidosteus of the early geological ages became clear to him only later in his study of the fossil fishes. He then detected the reptilian character of the type, and saw that from the articulation of the vertebræ the head must have moved more freely on the trunk than that of any fish of our days. To his great delight, when the first living specimen of the gar-pike, or modern Lepidosteus,

was brought to him, it moved its head to the right and left and upward, as a Saurian does and as no other fish can.

The result of this expedition was a valuable collection of fishes and a report upon the fauna and the geology of Lake Superior, comprising the erratic phenomena. A narrative written by James Elliot Cabot formed the introduction to the report, and it was also accompanied by two or three shorter contributions on special subjects from other members of the party. The volume was illustrated by a number of plates exquisitely drawn and colored on stone by A. Sonrel.

This was not Agassiz's first publication in America. His "Principles of Zoölogy" (Agassiz and Gould) was published in 1848. The book had a large sale, especially for schools. Edition followed edition, but the sale of the first part was checked by the want of the second, which was never printed. Agassiz was always swept along so rapidly by the current of his own activity that he was sometimes forced to leave behind him unfinished work. Before the time came for the completion of the second part of the zoölogy, his own knowledge had matured so much, that to be true to the facts, he must have remodeled the

whole of the first part, and for this he never found the time. Apropos of these publications the following letters are in place.

FROM SIR RODERICK MURCHISON.

BELGRAVE SQUARE, *October* 3, 1849.

. . . I thank you very sincerely for your most captivating general work on the "Principles of Zoölogy." I am quite in love with it. I was glad to find that you had arranged the nummulites with the tertiary rocks, so that the broad generalization I attempted in my last work on the Alps, Apennines, and Carpathians is completely sustained zoölogically, and you will not be sorry to see the stratigraphical truth vindicated (versus E. de Beaumont and ——). I beseech you to look at my memoir, and especially at my reasoning about the miocene and pliocene divisions of the Alps and Italy. It seems to me manifest that the percentage system derived from marine life can never be applied to tertiary *terrestrial* successions. . . .

My friends have congratulated me much on this my last effort, and as Lyell and others most interested in opposing me have been forward in approval, I begin to hope that I am not yet quite done up; and that unlike

the Bishop of Oviedo, my last sermon "ne sent pas de l'apoplexie." I have, nevertheless, been desperately out of sorts and full of gout and liver and all kinds of irritation this summer, which is the first for many a long year in which I have been unable to take the field. The meeting at Birmingham, however, revived me. Professor W. Rogers will have told you all about our doings. Buckland is up to his neck in "sewage," and wishes to change all underground London into a fossil cloaca of pseudo coprolites. This does not quite suit the chemists charged with sanitary responsibilities; for they fear the Dean will poison half the population in preparing his choice manures! But in this as in everything he undertakes there is a grand sweeping view.

When are we to meet again? And when are we to have a "stand-up fight" on the erratics of the Alps? You will see by the abstract of my memoir appended to my Alpine affair that I have taken the field against the extension of the Jura! In a word, I do not believe that great trunk glaciers ever filled the valleys of the Rhone, etc. Perhaps you will be present at our next meeting of the British Association at Edinburgh, August,

1850. *Olim meminisse juvabit!* and then, my dear and valued and most enlightened friend, we may study once more together the surface of my native rocks for "auld lang syne." . . .

FROM CHARLES DARWIN.

DOWN, FARNBOROUGH, KENT,
June 15 [1850, probably].

MY DEAR SIR, — I have seldom been more deeply gratified than by receiving your most kind present of "Lake Superior." I had heard of it, and had much wished to read it, but I confess it was the very great honor of having in my possession a work with your autograph, as a presentation copy, that has given me such lively and sincere pleasure. I cordially thank you for it. I have begun to read it with uncommon interest, which I see will increase as I go on.

The Cirrepedia, which you and Dr. Gould were so good as to send me, have proved of great service to me. The sessile species from Massachusetts consist of five species. . . . Of the genus Balanus, on the shores of Britain, we have *one* species (B. perforata Bruguière), which you have not in the United States, in the same way as you exclusively

have B. eburneus. All the above species attain a somewhat larger average size on the shores of the United States than on those of Britain, but the specimens from the glacial beds of Uddevalla, Scotland, and Canada, are larger even than those of the United States.

Once again allow me to thank you with cordiality for the pleasure you have given me.

Believe me, with the highest respect, your truly obliged,

C. DARWIN.

The following letter from Hugh Miller concerning Agassiz's intention of introducing "The Footprints of the Creator" to the American public by a slight memoir of Miller is of interest here. It is to be regretted that with this exception no letters have been found from him among Agassiz's papers, though he must have been in frequent correspondence with him, and they had, beside their scientific sympathy, a very cordial personal relation.

EDINBURGH, 2 STUART STREET, *May* 25, 1850.

DEAR SIR, — I was out of town when your kind letter reached here, and found such an accumulation of employment on my return that it is only now I find myself able to devote

half an hour to the work of reply, and to say how thoroughly sensible I am of the honor you propose doing me. It never once crossed my mind when, in writing my little volume, the "Footprints," I had such frequent occasion to refer to my master, our great authority in ichthyic history, that he himself would have associated his name with it on the other side of the Atlantic, and referred in turn to its humble writer.

In the accompanying parcel I send you two of my volumes, which you may not yet have seen, and in which you may find some materials for your proposed introductory memoir. At all events they may furnish you with amusement in a leisure hour. The bulkier of the two, "Scenes and Legends," of which a new edition has just appeared, and of which the first edition was published, after lying several years beside me, in 1835, is the earliest of my works to which I attached my name. It forms a sort of traditionary history of a district of Scotland, about two hundred miles distant from the capital, in which the character of the people has been scarce at all affected by the cosmopolitanism which has been gradually modifying and altering it in the larger towns; and as it has been fre-

quently remarked, — I know not with what degree of truth, — that there is a closer resemblance between the Scotch and Swiss than between any other two peoples of Europe, you may have some interest in determining whether the features of your own countryfolk are not sometimes to be seen in those of mine, as exhibited in my legendary history. Certainly both countries had for many ages nearly the same sort of work to do; both had to maintain a long and ultimately successful war of independence against nations greatly more powerful than themselves; and as their hills produced little else than the "soldier and his sword," both had to make a trade abroad of that art of war which they were compelled in self-defense to acquire at home. Even in the laws of some nations we find them curiously enough associated together. In France, under the old régime, the personal property of all strangers dying in the country, *Swiss and Scots excepted*, was forfeited to the king.

The other volume, "First Impressions of England and its People," contains some personal anecdotes and some geology. But the necessary materials you will chiefly find in the article from the "North British Review" which I also inclose. It is from the pen of

Sir David Brewster, with whom for the last ten years I have spent a few very agreeable days every year at Christmas, under the roof of a common friend, — one of the landed proprietors of Fifeshire. Sir David's estimate of the writer is, I fear, greatly too high, but his statement of facts regarding him is correct; and I think you will find it quite full enough for the purposes of a brief memoir. With his article I send you one of my own, written about six years ago for the same periodical, as the subject is one in which, from its connection with your master study, — the natural history of fishes, — you may take more interest than most men. It embodies, from observation, what may be regarded as *the natural history of the fisherman*, and describes some curious scenes and appearances which I witnessed many years ago when engaged, during a truant boyhood, in prosecuting the herring fishery as an amateur. Many of my observations of natural phenomena date from this idle, and yet not wholly wasted, period of my life.

With the volumes I send also a few casts of my less fragile specimens of Asterolepis. Two of the number, those of the external and internal surfaces of the creature's cranial buck-

ler, are really very curious combinations of plates, and when viewed in a slant light have a decidedly sculpturesque and not ungraceful effect. I have seen on our rustic tombstones worse representations of angels, winged and robed, than that formed by the central plates of the interior surface when the light is made to fall along their higher protuberances, leaving the hollows in the shade. You see how truly your prediction regarding the flatness of the creature's head is substantiated by these casts; it is really not easy to know how, placed on so flat a surface, the eyes could have been very available save for star-gazing; but as nature makes no mistakes in such matters, it is possible that the creature, like the flat-fishes, may have lived much at the bottom, and that most of the seeing it had use for may have been seeing in an upward direction. None of my other specimens of bucklers are so entire and in so good a state of keeping as the two from which I have taken the casts, but they are greatly larger. One specimen, nearly complete, exhibits an area about four times as great as the largest of these two, and I have fragments of others which must have belonged to fish still more gigantic. The two other casts are of specimens of gill covers,

which in the Asterolepis, as in the sturgeon, consisted each of a single plate. In both the exterior surface of the buckler and of the operculum the tubercles are a good deal enveloped in the stone, which is of a consistency too hard to be removed without injuring what it overlies; but you will find them in the smaller cast which accompanies the others, and which, as shown by the thickness of the plate in the original, indicates their size and form in a large individual, very characteristically shown. So coral-like is their aspect, that if it was from such a cast, not a fossil (which would, of course, exhibit the peculiarities of the bone), that Lamarck founded his genus Monticularia, I think his apology for the error might almost be maintained as good. I am sorry I cannot venture on taking casts from some of my other specimens; but they are exceedingly fragile, and as they are still without duplicates I am afraid to hazard them. Since publishing my little volume I have got several new plates of Asterolepis, — a broad palatal plate, covered with tubercles, considerably larger than those of the creature's external surface, — a key-stone shaped plate, placed, when *in situ*, in advance of the little plate between the eyes, which form the head

and face of the effigy in the centre of the buckler, — and a side-plate, into which the condyloid processes of the lower jaw were articulated, and which exhibited the processes on which these hinged. There are besides some two or three plates more, whose places I have still to find. The small cast, stained yellow, is taken from an instructive specimen of the jaws of coccosteus, and exhibits a peculiarity which I had long suspected and referred to in the first edition of my volume on the Old Red Sandstone in rather incautious language, but which a set of my specimens now fully establishes. Each of the under jaws of the fish was furnished with two groups of teeth: one group in the place where, in quadrupeds, we usually find the molars; and another group in the line of the symphyses. And how these both could have acted is a problem which our anatomists here — many of whom have carefully examined my specimen — seem unable, and in some degree, indeed, afraid to solve.

I have written to the Messrs. Gould, Kendall & Lincoln to say that the third edition of the "Footprints" differs from the first and second only by the addition of a single note and an illustrative diagram, both of which I

have inclosed to them in my communication. I anticipate much pleasure from the perusal of your work on Lake Superior, when it comes to hand, which, as your publishers have intrusted it to the care of a gentleman visiting this country, will, I think, be soon. It is not often that a region so remote and so little known as that which surrounds the great lake of America is visited by a naturalist of the first class. From such a *terra incognita*, at length unveiled to eyes so discerning, I anticipate strange tidings.

I am, my dear sir, with respect and admiration, very truly yours,

HUGH MILLER.

In the spring of 1850 Agassiz married Elizabeth Cabot Cary, daughter of Thomas Graves Cary, of Boston. This marriage confirmed his resolve to remain, at least for the present, in the United States. It connected him by the closest ties with a large family circle, of which he was henceforth a beloved and honored member, and made him the brother-in-law of one of his most intimate friends in Cambridge, Professor C. C. Felton. Thus secure of favorable conditions for the care and education of his children, he called

them to this country. His son (then a lad of fifteen years of age) had joined him the previous summer. His daughters, younger by several years than their brother, arrived the following autumn, and home built itself up again around him.

The various foreign members of his household had already scattered. One or two had returned to Europe, others had settled here in permanent homes of their own. Among the latter were Professor Guyot and M. de Pourtalès, who remained, both as scientific colleagues and personal friends, very near and dear to him all his life. "Papa Christinat" had also withdrawn. While Agassiz was absent on a lecturing tour, the kind old man, knowing well the opposition he should meet, and wishing to save both himself and his friend the pain of parting, stole away without warning and went to New Orleans, where he had obtained a place as pastor. This was a great disappointment to Agassiz, who had urged him to make his home with him, a plan in which his wife and children cordially concurred, but which did not approve itself to the judgment of his old friend. M. Christinat afterward returned to Switzerland, where he ended his days. He wrote constantly until

his death, and was always kept advised of everything that passed in the family at Cambridge. Of the old household, Mr. Burkhardt alone remained a permanent member of the new one.

CHAPTER XVI.

1850 – 1852 : ÆT. 43–45.

Proposition from Dr. Bache. — Exploration of Florida Reefs. — Letter to Humboldt concerning Work in America. — Appointment to Professorship of Medical College in Charleston, S. C. — Life at the South. — Views concerning Races of Men. — Prix Cuvier.

THE following letter from the Superintendent of the Coast Survey determined for Agassiz the chief events of the winter of 1851.

FROM ALEXANDER DALLAS BACHE.

WEBB'S HILL, *October* 30, 1850.

MY DEAR FRIEND, — Would it be possible for you to devote six weeks or two months to the examination of the Florida reefs and keys in connection with their survey? It is extremely important to ascertain what they are and how formed. One account treats them as growing corals, another as masses of something resembling oölite, piled together, barrier-wise. You see that this lies at the root of the progress of the reef, so important to

navigation, of the use to be made of it in placing our signals, of the use as a foundation for light-houses, and of many other questions practically important and of high scientific interest. I would place a vessel at your disposal during the time you were on the reef, say six weeks.

The changes at or near Cape Florida, from the Atlantic coast and its silicious sand, to the Florida coast and its coral sand, must be curious. You will be free to move from one end of the reef to the other, which will be, say one hundred and fifty miles. Motion to eastward would be slow in the windy season, though favored by the Gulf Stream as the winds are "trade." Whatever collections you might make would be your own. I would only ask for the survey such information and such specimens as would be valuable to its operations, especially to its hydrography, and some report on these matters. As this will, if your time and engagements permit, lead to a business arrangement, I must, though reluctantly, enter into that. I will put aside six hundred dollars for the two months, leaving you to pay your own expenses; or, if you prefer it, will pay all expenses of travel, including subsistence, to and from Key West,

and furnish vessel and subsistence while there, and four hundred dollars.

What results would flow to science from your visit to that region! You have spoken of the advantage of using our vessels when they were engaged in their own work. Now I offer you a vessel the motions of which you will control, and the assistance of the officers and crew of which you will have. You shall be at no expense for going and coming, or while there, and shall choose your own time. . . .

Agassiz accepted this proposal with delight, and at once made arrangements to take with him a draughtsman and an assistant, in order to give the expedition such a character as would make it useful to science in general, as well as to the special objects of the Coast Survey. It will be seen that Dr. Bache gladly concurred in all these views.

FROM ALEXANDER DALLAS BACHE.

WASHINGTON, *December* 18, 1850.

MY DEAR FRIEND, — On the basis of our former communications I have been, as the time served, raising a superstructure. I have arranged with Lieutenant Commander Alden

to send the schooner W. A. Graham, belonging to the Coast Survey, under charge of an officer who will take an interest in promoting the great objects in which you will be engaged, to Key West, in time to meet you on your arrival in the Isabel of the 15th, from Charleston to Key West. The vessel will be placed at your absolute disposal for four to six weeks, as you may find desirable, doing just such things as you require, and going to such places as you direct. If you desire more than a general direction, I will give any specific ones which you may suggest. . . .

I have requested that room be made in the cabin for you and for two aids, as you desire to take a draughtsman with you; and in reference to your enlarged plan of operating, of which I see the advantage, I have examined the financial question, and propose to add two hundred dollars to the six hundred in my letter of October 30th, to enable you to execute it. I would suggest that you stop a day in Washington on your way to Charleston, to pick up the topographical and geographical information which you desire, and to have all matters of a formal kind arranged to suit your convenience and wishes, which, I am sure, will all be promotive of the objects in

view from your visit to Florida. . . . You say I shall smile *at* your plans, — instead of which, they have been smiled *on*; now, there is a point for you, — a true Saxon distinction.

If you succeed (and did you ever fail!?) in developing for our Coast Survey the nature, structure, growth, and all that, of the Florida reefs, you will have conferred upon the country a priceless favor. . . .

The Superintendent of the Coast Survey never had cause to regret the carte-blanche he had thus given. A few weeks, with the facilities so liberally afforded, gave Agassiz a clew to all the phenomena he had been commissioned to examine, and enabled him to explain the relation between the keys and the outer and inner reefs, and the mud swamps, or more open channels, dividing them, and to connect these again with the hummocks and everglades of the main-land. It remains to be seen whether his theory will hold good, that the whole or the greater part of the Florida peninsula has, like its southern portion, been built up of concentric reefs. But his explanation of the present reefs, their structure, laws of growth, relations to each other and to the main-land, as well as to the Gulf

Stream and its prevailing currents, was of great practical service to the Coast Survey. It was especially valuable in determining how far the soil now building up from accumulations of mud and coral débris was likely to remain for a long time shifting and uncertain, and how far and in what localities it might be relied upon as affording a stable foundation. When, at the meeting of the American Association in the following spring, Agassiz gave an account of his late exploration, Dr. Bache, who was present, said that for the first time he understood the bearing of the whole subject, though he had so long been trying to unravel it.

The following letter was written immediately after Agassiz's return.

TO SIR CHARLES LYELL.

CAMBRIDGE, *April* 26, 1851.

. . . I have spent a large part of the winter in Florida, with a view of studying the coral reefs. I have found that they constitute a new class of reefs, distinct from those described by Darwin and Dana under the name of fringing reefs, barrier reefs, and atolls. I have lately read a paper upon that subject before the American Academy, which

I shall send you as soon as it is printed. The case is this. There are several concentric reefs separated by deep channels; the peninsula of Florida itself is a succession of such reefs, the everglades being the filled-up channels, while the hummocks were formerly little intervening islands, like the mangrove islands in the present channels. But what is quite remarkable, all these concentric reefs are upon one level, above that of the sea, and there is no indication whatever of upheaval. You will find some observations upon upheavals, etc., in Silliman, by Tuomey; it is a great mistake, as I shall show. The Tortugas are a real atoll, but formed without the remotest indication of subsidence.

Of course this does not interfere in the least with the views of Darwin, for the whole ground presents peculiar features. I wish you would tell him something about this. One of the most remarkable peculiarities of the rocks in the reefs of the Tortugas consists in their composition; they are chiefly made up of *Corallines*, limestone algæ, and, to a small extent only, of real corals. . . .

Agassiz's report to the Coast Survey upon the results of this first investigation made by

him upon the reefs of Florida was not published in full at the time. The parts practically most important to the Coast Survey were incorporated in their subsequent charts; the more general scientific results, as touching the physical history of the peninsula as a whole, appeared in various forms, were embodied in Agassiz's lectures, and were printed some years after in his volume entitled "Methods of Study." The original report, with all the plates prepared for it, was published in the "Memoirs of the Museum of Comparative Zoölogy," under the supervision of Alexander Agassiz, after the death of his father. It forms a quarto volume, containing some sixty pages of text, with twenty-two plates, illustrative of corals and coral structure, and a map of Southern Florida with its reefs and keys.

This expedition was also of great importance to Agassiz's collections, and to the embryo museum in Cambridge. It laid the foundation of a very complete collection of corals of all varieties and in all stages of growth. All the specimens, from huge coral heads and branching fans down to the most minute single corals, were given up to him, the value of the whole being greatly enhanced by the drawings taken on the spot from the living animals.

To this period belongs also the following fragment of a letter to Humboldt.

TO ALEXANDER VON HUMBOLDT.

[Probably 1852, — date not given.]

. . . What a time has passed since my last letter! Had you not been constantly in my thoughts, and your counsels always before me as my guide, I should reproach myself for my silence. I hope my two papers on the medusæ, forwarded this year, have reached you, and also one upon the classification of insects, as based upon their development. I have devoted myself especially to the organization of the invertebrate animals, and to the facts bearing upon the perfecting of their classification. I have succeeded in tracing the same identity of structure between the three classes of radiates, and also between those of mollusks, as has already been recognized in the vertebrates, and partially in the articulates. It is truly a pleasure for me now to be able to demonstrate in my lectures the insensible gradations existing between polyps, medusæ, and echinoderms, and to designate by the same name organs seemingly so different. Especially has the minute examination of the thickness of the test in echinoderms revealed

to me unexpected relations between the sea-urchin and the medusa. No one suspects, I fancy, at this moment, that the solid envelope of the Scutellæ and the Clypeasters is traversed by a net-work of radiating tubes, corresponding to those of the medusæ, so well presented by Ehrenberg in Aurelia aurita. If the Berlin zoölogists will take the trouble to file off the surface of the test of an Echinarachnius parma, they will find a circular canal as large and as continuous as that of the medusæ. The aquiferous tubes specified above open into this canal. But the same thing may be found under various modifications in other genera of the family. Since I have succeeded in injecting colored liquid into the beroids, for instance, and keeping them alive with it circulating in their transparent mass, I am able to show the identity of their zones of locomotive fringes (combs), from which they take their name of Ctenophoræ, with the ambulacral (locomotive) apparatus of the echinoderms. Furnished with these facts, it is not difficult to recognize true beroidal forms in the embryos of sea-urchins and star-fishes, published by Müller in his beautiful plates, and thus to trace the medusoid origin of the echinoderms, as the polypoid origin of the

medusæ has already been recognized. I do not here allude to their primitive origin, but simply to the general fact that among radiates the embryos of the higher classes represent, in miniature, types of the lower classes, as, for instance, those of the echinoderms resemble the medusæ, those of the medusæ the polyps. Having passed the greater part of last winter in Florida, where I was especially occupied in studying the coral reefs, I had the best opportunity in the world for prosecuting my embryological researches upon the stony corals. I detected relations among them which now enable me to determine the classification of these animals according to their mode of development with greater completeness than ever before, and even to assign a superior or inferior rank to their different types, agreeing with their geological succession, as I have already done for the fishes. I am on the road to the same results for the mollusks and the articulates, and can even now say in general terms, that the most ancient representatives of all the families belonging to these great groups, strikingly recall the first phases in the embryonic development of their successors in more recent formations, and even that the embryos of comparatively recent

families recall families belonging to ancient epochs. You will find some allusion to these results in my Lectures on Embryology, given in my "Lake Superior," of which I have twice sent you a copy, that it might reach you the more surely; but these first impressions have assumed greater coherence now, and I constantly find myself recurring to my fossils for light upon the embryonic forms I am studying and *vice versa*, consulting my embryological drawings in order to decipher the fossils with greater certainty.

The proximity of the sea and the ease with which I can visit any part of the coast within a range of some twenty degrees give me inexhaustible resources for the whole year, which, as time goes on, I turn more and more to the best account. On the other hand, the abundance and admirable state of preservation of the fossils found in our ancient deposits, as well as the regular succession of the beds containing them, contribute admirable material for this kind of comparative study. . . .

In the summer of 1851 Agassiz was invited to a professorship at the Medical College in Charleston, S. C. This was especially ac-

ceptable to him, because it substituted a regular course of instruction to students, for the disconnected lectures given to miscellaneous audiences, in various parts of the country, by which he was obliged to eke out his small salary and provide for his scientific expenses. While more fatiguing than class-room work, these scattered lectures had a less educational value, though, on the other hand, they awakened a very wide-spread interest in the study of nature. The strain of constant traveling for this purpose, the more harassing because so unfavorable to his habits of continuous work, had already told severely upon his health; and from this point of view also the new professorship was attractive, as promising a more quiet, though no less occupied, life. The lectures were to be given during the three winter months, thus occupying the interval between his autumn and spring courses at Cambridge.

He assumed his new duties at Charleston in December, 1851, and by the kindness of his friend Mrs. Rutledge, who offered him the use of her cottage for the purpose, he soon established a laboratory on Sullivan's Island, where the two or three assistants he had brought with him could work conveniently.

The cottage stood within hearing of the wash of the waves, at the head of the long, hard sand beach which fringed the island shore for some three or four miles. There could hardly be a more favorable position for a naturalist, and there, in the midst of their specimens, Agassiz and his band of workers might constantly be found. His studies here were of the greater interest to him because they connected themselves with his previous researches, not only upon the fishes, but also upon the lower marine animals of the coast of New England and of the Florida reefs; so that he had now a basis for comparison of the fauna scattered along the whole Atlantic coast of the United States. The following letter gives some idea of his work at this time.

TO PROFESSOR JAMES D. DANA.

CHARLESTON, *January* 26, 1852.

MY DEAR FRIEND, — You should at least know that I think of you often on these shores. And how could I do otherwise when I daily find new small crustacea, which remind me of the important work you are now preparing on that subject.

Of course, of the larger ones there is nothing to be found after Professor Gibbes has gone

over the ground, but among the lower orders there are a great many in store for a microscopic observer. I have only to regret that I cannot apply myself more steadily. I find my nervous system so over-excited that any continuous exertion makes me feverish. So I go about as much as the weather allows, and gather materials for better times.

Several interesting medusæ have been already observed; among others, the entire metamorphosis and alternate generation of a new species of my genus tiaropsis. You will be pleased to know that here, as well as at the North, tiaropsis is the medusa of a campanularia. Mr. Clark, one of my assistants, has made very good drawings of all its stages of growth, and of various other hydroid medusæ peculiar to this coast. Mr. Stimpson, another very promising young naturalist, who has been connected with me for some time in the same capacity, draws the crustacea and bryozoa, of which there are also a good many new ones here. My son and my old friend Burkhardt are also with me (upon Sullivan's Island), and they look after the larger species, so that I shall probably have greatly increased my information upon the fauna of the Atlantic coast by the time I return to Cambridge.

In town, where I go three times a week to deliver lectures at the Medical College (beside a course just now in the evening also before a mixed audience), I have the rest of my family, so that nothing would be wanting to my happiness if my health were only better. . . . What a pity that a man cannot work as much as he would like; or at least accomplish what he aims at. But no doubt it is best it should be so; there is no harm in being compelled by natural necessities to limit our ambition, — on the contrary, the better sides of our nature are thus not allowed to go to sleep. However, I cannot but regret that I am unable at this time to trace more extensively subjects for which I should have ample opportunities here, as for instance the anatomy of the echinoderms, and also the embryology of the lower animals in general. . . .

This winter, notwithstanding the limitations imposed upon his work by the state of his health, was a very happy one to Agassiz. As mentioned in the above letter his wife and daughters had accompanied him to Charleston, and were established there in lodgings. Their holidays and occasional vacations were passed at the house of Dr. John E. Holbrook

(the "Hollow Tree"), an exquisitely pretty and picturesque country place in the neighborhood of Charleston. Here Agassiz had been received almost as one of the family on his first visit to Charleston, shortly after his arrival in the United States. Dr. Holbrook's name, as the author of the "Herpetology of South Carolina," had long been familiar to him, and he now found a congenial and affectionate friend in the colleague and fellow-worker, whose personal acquaintance he had been anxious to make. Dr. Holbrook's wife, a direct descendant of John Rutledge of our revolutionary history, not only shared her husband's intellectual life, but had herself rare mental qualities, which had been developed by an unusually complete and efficient education. The wide and various range of her reading, the accuracy of her knowledge in matters of history and literature, and the charm of her conversation, made her a delightful companion. She exercised the most beneficent influence upon her large circle of young people, and without any effort to attract, she drew to herself whatever was most bright and clever in the society about her. The "Hollow Tree," presided over by its hospitable host and hostess was, therefore,

the centre of a stimulating and cultivated social intercourse, free from all *gêne* or formality. Here Agassiz and his family spent many happy days during their southern sojourn of 1852. The woods were yellow with jessamine, and the low, deep piazza was shut in by vines and roses; the open windows and the soft air full of sweet, out-of-door fragrance made one forget, spite of the wood fire on the hearth, that it was winter by the calendar. The days, passed almost wholly in the woods or on the veranda, closed with evenings spent not infrequently in discussions upon the scientific ideas and theories of the day, carried often beyond the region of demonstrated facts into that of speculative thought. An ever-recurring topic was that of the origin of the human race. It was Agassiz's declared belief that man had sprung not from a common stock, but from various centres, and that the original circumscription of these primordial groups of the human family corresponded in a large and general way with the distribution of animals and their combination into faunæ.[1] His special zoölogical studies were too en-

[1] See *Sketch of the Natural Provinces of the Animal World and their Relation to the Different Types of Man* included in Nott & Gliddon's *Types of Mankind*.

grossing to allow him to follow this line of investigation closely, but it was never absent from his view of the animal kingdom as a whole. He valued extremely Mrs. Holbrook's thoughtful sympathy, and as the following letter connects itself with the winter evening talks by the "Hollow Tree" fireside, and was suggested by them, it may be given here, though in date it is a little in advance of the present chapter.

TO MRS. HOLBROOK.

CAMBRIDGE, *July*, 1852.

. . . I am again working at the human races, and have opened another line of investigation in that direction. The method followed by former investigators does not seem to me to have been altogether the best, since there is so little agreement between them. The difficulty has, no doubt, arisen on one side from the circumstance that the inquirer sought for evidence of the unity of all races, expecting the result to agree with the prevailing interpretation of Genesis; and on the other from too zoölogical a point of view in weighing the differences observed. Again, both have almost set aside all evidence not directly derived from the examination of the

races themselves. It has occurred to me that as a preliminary inquiry we ought to consider the propriety of applying to man the same rules as to animals, examining the limits within which they obtain, and paying due attention to all circumstances bearing upon the differences observed among men, from whatever quarter in the study of nature they may be gathered. What do the monkeys say to this? or, rather, what have they to tell in reference to it? There are among them as great, and, indeed, even greater, differences than among men, for they are acknowledged to constitute different genera, and are referred to many, indeed to more than a hundred, species; but they are the nearest approach to the human family, and we may at least derive some hints from them. How much mixture there is among these species, if any, is not at all ascertained; indeed, we have not the least information respecting their intercourse; but one point is certain, — zoölogists agree as little among themselves respecting the limits of these species as they do respecting the affinities of the races of men. What some consider as distinct species, others consider as mere varieties, and these varieties or species differ in particulars neither more constant nor more

important than those which distinguish the human races. The fact that they are arranged in different genera, species, and varieties does not lessen the value of the comparison; for the point in question is just to know whether nations, races, and what have also been called families of men, such as the Indo-Germanic, the Semitic, etc., do not in reality correspond to the families, genera, and species of monkeys. Now the first great subdivisions among the true monkeys (excluding Makis and Arctopitheci) are founded upon the form of the nose, those of the new world having a broad partition between the nostrils, while those of the old world have it narrow. How curious that this fact, which has been known to naturalists for half a century, as presenting a leading feature among monkeys, should have been overlooked in man, when, in reality, the negroes and Australians differ in precisely the same manner from the other races; they having a broad partition, and nostrils opening sideways, like the monkeys of South America, while the other types of the human family have a narrow partition and nostrils opening downward, like the monkeys of Asia and Africa. Again, the minor differences, such as the obliquity of the anterior

teeth, the thickness of the lips, the projection of the cheek-bones, the position of the eyes, the characteristic hair, or wool, afford as constant differences as those by which the chimpanzees, orangs, and gibbons are separated into distinct genera; and their respective species differ no more than do the Greeks, Germans, and Arabs, — or the Chinese, Tartars, and Finns, — or the New Zealanders and Malays, which are respectively referred to the same race. The truth is, that the different *species* admitted by some among the orangs are in reality *races* among monkeys, or else the races among men are nothing more than what are called species among certain monkeys. . . . Listen for a moment to the following facts, and when you read this place a map of the world before you. Upon a narrow strip of land along the Gulf of Guinea, from Cape Palmas to the Gaboon, live two so-called species of chimpanzee; upon the islands of Sumatra and Borneo live three or four orangs; upon the shores of the Gulf of Bengal, including the neighborhood of Calcutta, Burmah, Malacca, Sumatra, Borneo, and Java together, ten or eleven species of gibbons, all of which are the nearest relatives to the human family, some being as large as

certain races of men; altogether, fifteen species of anthropoid monkeys playing their part in the animal population of the world upon an area not equaling by any means the surface of Europe. Some of these species are limited to Borneo, others to Sumatra, others to Java alone, others to the peninsula of Malacca; that is to say to tracts of land similar in extent to Spain, France, Italy, and even to Ireland; distinct animals, considered by most naturalists as distinct species, approaching man most closely in structural eminence and size, limited to areas not larger than Spain or Italy. Why, then, should not the primitive theatre of a nation of men have been circumscribed within similar boundaries, and from the beginning have been as independent as the chimpanzee of Guinea, or the orangs of Borneo and Sumatra? Of course, the superior powers of man have enabled him to undertake migrations, but how limited are these, and how slight the traces they have left behind them. . . . Unfortunately for natural history, history so-called has recorded more faithfully the doings of handfuls of adventurers than the real history of the primitive nations with whom the migrating tribes came into contact. But I hope it will yet be pos-

sible to dive under these waves of migration, to remove, as it were, the trace of their passage, and to read the true history of the past inhabitants of the different parts of the world, when it will be found, if all analogies are not deceptive, that every country equaling in extent those within the limits of which distinct nationalities are known to have played their part in history, has had its distinct aborigines, the character of which it is now the duty of naturalists to restore, if it be not too late, in the same manner as paleontologists restore fossil remains. I have already made some attempts, by studying ancient geography, and I hope the task may yet be accomplished. Look, for instance, at Spain. The Iberians are known as the first inhabitants, never extending much beyond the Pyrenees to the Garonne, and along the gulfs of Lyons and Genoa. As early as during the period of Phœnician prosperity they raised wool from their native sheep, derived from the Mouflon, still found wild in Spain, Corsica, and Sardinia; they had a peculiar breed of horses, to this day differing from all other horses in the world. Is this not better evidence of their independent origin, than is the fancied lineage with the Indo-Germanic family of their

Oriental descent? For we must not forget, in connection with this, that the Basque language was once the language of all Spain, that which the Iberian spoke, and which has no direct relation to Sanskrit.

I have alluded but slightly to the negro race, and not at all to the Indians. I would only add with reference to these that I begin to perceive the possibility of distinguishing different centres of growth in these two continents. If we leave out of consideration fancied migrations, what connection can be traced, for instance, between the Eskimos, along the whole northern districts of this continent, and the Indians of the United States, those of Mexico, those of Peru, and those of Brazil? Is there any real connection between the coast tribes of the northwest coast, the mound builders, the Aztec civilization, the Inca, and the Gueranis? It seems to me no more than between the Assyrian and Egyptian civilization. And as to negroes, there is, perhaps, a still greater difference between those of Senegal, of Guinea, and the Caffres and Hottentots, when compared with the Gallahs and Mandingoes. But where is the time to be taken for the necessary investigations involved in these inquiries? Pray write to

me soon what you say to all this, and believe me always your true friend,

L. Agassiz.

In the spring of 1852, while still in Charleston, Agassiz heard that the Prix Cuvier, now given for the first time, was awarded to him for the "Poissons Fossiles." This gratified him the more because the work had been so directly bequeathed to him by Cuvier himself. To his mother, through whom he received the news in advance of the official papers, it also gave great pleasure. "Your fossil fishes," she says, "which have cost you so much anxiety, so much toil, so many sacrifices, have now been estimated at their true value by the most eminent judges. . . . This has given me such happiness, dear Louis, that the tears are in my eyes as I write it to you." She had followed the difficulties of his task too closely not to share also its success.

CHAPTER XVII.

1852–1855: ÆT. 45–48.

Return to Cambridge. — Anxiety about Collections. — Purchase of Collections. — Second Winter in Charleston. — Illness. — Letter to James D. Dana concerning Geographical Distribution and Geological Succession of Animals. — Resignation of Charleston Professorship. — Propositions from Zurich. — Letter to Oswald Heer. — Decision to remain in Cambridge. — Letters to James D. Dana, S. S. Haldeman, and Others respecting Collections illustrative of the Distribution of Fishes, Shells, etc., in Our Rivers. — Establishment of Schools for Girls.

AGASSIZ returned from Charleston to Cambridge in the early spring, pausing in Washington to deliver a course of lectures before the Smithsonian Institution. By this time he had become intimate with Professor Henry, at whose hospitable house he and his family were staying during their visit at Washington. He had the warmest sympathy not only with Professor Henry's scientific work and character, but also with his views regarding the Smithsonian Institution, of which he had become the Superintendent shortly after Agassiz arrived in this country. Agassiz himself was soon appointed one of the Regents of the

Institution and remained upon the Board until his death.

Agassiz now began to feel an increased anxiety about his collections. During the six years of his stay in the United States he had explored the whole Atlantic sea-board as well as the lake and river system of the Eastern and Middle States, and had amassed such materials in natural history as already gave his collections, in certain departments at least, a marked importance. In the lower animals, and as illustrating the embryology of the marine invertebrates, they were especially valuable. It had long been a favorite idea with him to build up an embryological department in his prospective museum; the more so because such a provision on any large scale had never been included in the plan of the great zoölogical institutions, and he believed it would have a direct and powerful influence on the progress of modern science. The collections now in his possession included ample means for this kind of research, beside a fair representation of almost all classes of the animal kingdom. Packed together, however, in the narrowest quarters, they were hardly within his own reach, much less could they be made available for others. His own resources

were strained to the utmost, merely to save these precious materials from destruction. It is true that in 1850 the sum of four hundred dollars, to be renewed annually, was allowed him by the University for their preservation, and a barrack-like wooden building on the college grounds, far preferable to the bath-house by the river, was provided for their storage. But the cost of keeping them was counted by thousands, not by hundreds, and the greater part of what Agassiz could make by his lectures outside of Cambridge was swallowed up in this way. It was, perhaps, the knowledge of this which induced certain friends, interested in him and in science, to subscribe twelve thousand dollars for the purchase of his collections, to be thus permanently secured to Cambridge. This gave him back, in part, the sum he had already spent upon them, and which he was more than ready to spend again in their maintenance and increase.

The next year showed that his over-burdened life was beginning to tell upon his health. Scarcely had he arrived in Charleston and begun his course at the Medical College when he was attacked by a violent fever, and his life was in danger for many days. Fortu-

nately for him his illness occurred at the "Hollow Tree," where he was passing the Christmas holidays. Dr. and Mrs. Holbrook were like a brother and sister to him, and nothing could exceed the kindness he received under their roof. One young friend who had been his pupil, and to whom he was much attached, Dr. St. Julian Ravenel, was constantly at his bedside. His care was invaluable, for he combined the qualities of physician and nurse. Under such watchful tending, Agassiz could hardly fail to mend if cure were humanly possible. The solicitude of these nearer friends seemed to be shared by the whole community, and his recovery gave general relief. He was able to resume his lectures toward the end of February. Spite of the languor of convalescence his elastic mind was at once ready for work, as may be seen by the following extract from one of his first letters.

TO JAMES D. DANA.

SULLIVAN'S ISLAND, CHARLESTON,
February 16, 1853.

. . . It seems, indeed, to me as if in the study of the geographical distribution of animals the present condition of the animal kingdom was too exclusively taken into considera-

tion. Whenever it can be done, and I hope before long it may be done for all classes, it will be desirable to take into account the relations of the living to the fossil species. Since you are as fully satisfied as I am that the location of animals, with all their peculiarities, is not the result of physical influences, but lies within the plans and intentions of the Creator, it must be obvious that the successive introduction of all the diversity of forms which have existed from the first appearance of any given division of the animal kingdom up to the present creation, must have reference to the location of those now in existence. For instance, if it be true among mammalia that the highest types, such as quadrumana, are essentially tropical, may it not be that the prevailing distribution of the inferior pachyderms within the same geographical limits is owing to the circumstance that their type was introduced upon earth during a warmer period in the history of our globe, and that their present location is in accordance with that fact, rather than related to their degree of organization? The pentacrinites, the lowest of the echinoderms, have only one living representative in tropical America, where we find at the same time the highest and largest

spatangi and holothuridæ. Is this not quite a parallel case with the monkeys and pachyderms? for once crinoids were the only representatives of the class of echinoderms. May we not say the same of crocodiles when compared with the ancient gigantic saurians? or are the crocodiles, as an order, distinct from the other saurians, and really higher than the turtles? Innumerable questions of this kind, of great importance for zoölogy, are suggested at every step, as soon as we compare the present distribution of animals with that of the inhabitants of former geological periods. Among crustacea, it is very remarkable that trilobites and limulus-like forms are the only representatives of the class during the paleozoic ages; that macrourans prevailed in the same manner during the secondary period; and that brachyurans make their appearance only in the tertiary period. Do you discover in your results any connection between such facts and the present distribution of crustacea? There is certainly one feature in their classification which must appear very striking, — that, taken on a large scale, the organic rank of these animals agrees in the main with their order of succession in geological times; and this fact is of no small

importance when it is found that the same correspondence between rank and succession obtains through all classes of the animal kingdom, and that similar features are displayed in the embryonic growth of all types so far as now known.

But I feel my head is growing dull, and I will stop here. Let me conclude by congratulating you on having completed your great work on crustacea. . . .

Agassiz returned to the North in the spring of 1853 by way of the Mississippi, stopping to lecture at Mobile, New Orleans, and St. Louis. On leaving Charleston he proffered his resignation with deep regret, for, beside the close personal ties he had formed, he was attached to the place, the people, and to his work there. He had hoped to establish a permanent station for sustained observations in South Carolina, and thus to carry on a series of researches which, taken in connection with his studies on the New England coast and its vicinity, and on the Florida reefs and shores, would afford a wide field of comparison. This was not to be, however. The Medical College refused, indeed, to accept his resignation, granting him, at the same time, a year of

absence. But it soon became evident that his health was seriously shaken, and that he needed the tonic of the northern winter. He was, indeed, never afterward as strong as he had been before this illness.

The winter of 1854 was passed in Cambridge with such quiet and rest as the conditions of his life would allow. In May of that year he received an invitation to the recently established University of Zurich, in Switzerland. His acceptance was urged upon the ground of patriotism as well as on that of a liberal endowment both for the professor, and for the museum of which he was to have charge. The offer was tempting, but Agassiz was in love (the word is not too strong) with the work he had undertaken and the hopes he had formed in America. He believed that by his own efforts, combined with the enthusiasm for science which he had aroused and constantly strove to keep alive and foster in the community, he should at last succeed in founding a museum after his own heart in the United States, — a museum which should not be a mere accumulation, however vast or extensive, of objects of natural history, but should have a well-combined and clearly expressed educational value. As we

shall see, neither the associations of his early life nor the most tempting scientific prizes in the gift of the old world could divert him from this settled purpose. The proposition from Zurich was not official, but came through a friend and colleague, for whom he had the deepest sympathy and admiration, — Oswald Heer. To work in his immediate neighborhood would have been in itself a temptation.

TO PROFESSOR OSWALD HEER.

CAMBRIDGE, *January* 9, 1855.

MY HONORED FRIEND, — How shall I make you understand why your kind letter, though it reached me some months ago, has remained till now unanswered. It concerns a decision of vital importance to my whole life, and in such a case one must not decide hastily, nor even with too exclusive regard for one's own preference in the matter. You cannot doubt that the thought of joining an institution of my native country, and thus helping to stimulate scientific progress in the land of my birth, my home, and my early friends, appeals to all I hold dear and honorable in life. On the other side I have now been eight years in America, have learned to understand the advantages of my position here, and have begun undertak-

ings which are not yet brought to a conclusion. I am aware also how wide an influence I already exert upon this land of the future, —an influence which gains in extent and intensity with every year, — so that it becomes very difficult for me to discern clearly where I can be most useful to science. Among my privileges I must not overlook that of passing much of my time on the immediate sea-shore, where the resources for the zoölogist and embryologist are inexhaustible. I have now a house distant only a few steps from an admirable locality for these studies, and can therefore pursue them uninterruptedly throughout the whole year, instead of being limited, like most naturalists, to the short summer vacations. It is true I miss the larger museums, libraries, etc., as well as the stimulus to be derived from association with a number of like-minded co-workers, all striving toward the same end. With every year, however, the number of able and influential investigators increases here, and among them are some who might justly claim a prominent place anywhere. . . .

Neither are means for publication lacking. The larger treatises with costly illustrations appear in the Smithsonian Contributions, in the

Transactions of the American Philosophical Society, in those of the Academy of Natural Sciences, and in the Memoirs of the American Academy; while the smaller communications find a place in Silliman's Journal, in the Journal of the Boston Natural History Society, and in the proceedings of other scientific societies. Museums also are already founded; . . . and beside these there are a number of private collections in single departments of zoölogy. . . . Better than all this, however, is the lively and general interest taken in the exploration of the country itself. Every scientific expedition sent out by the government to the interior, or to the Western States of Oregon and California, is accompanied by a scientific commission, — zoölogists, geologists, and botanists. By this means magnificent collections, awaiting only able investigators to work them up, have been brought together. Indeed, I do not believe that as many new things are accumulated anywhere as just here, and it is my hope to contribute hereafter to the more critical and careful examination of these treasures. Under these circumstances I have asked myself for months past how I ought to decide; not what were my inclinations, for that is not the question, — but what

was my duty toward science? After the most careful consideration I am no longer in doubt, and though it grieves me to do so, I write to beg that you will withdraw from any action which might bring me a direct call to the professorship in Zurich. I have decided to remain here for an indefinite time, under the conviction that I shall exert a more advantageous and more extensive influence on the progress of science in this country than in Europe.

I regret that I cannot accept your offer of the Oeningen fossils. In the last two years I have spent more than 20,000 francs on my collection, and must not incur any farther expense of that kind at present. As soon, however, as I have new means at my command such a collection would be most welcome, and should it remain in your hands I may be very glad to take it. Neither can I make any exchange of duplicates just now, as I have not yet been able to sort my collections and set aside the specimens which may be considered only as materials for exchange. Can you procure for me Glarus fishes in any considerable number? I should like to purchase them for my collection, and do not care for single specimens of every species, but would prefer

whole suites that I may revise my former identifications in the light of a larger insight.

Remember me kindly to all my Zurich friends, and especially to Arnold Escher. . . .

Agassiz's increasing and at last wholly unmanageable correspondence attests the general sympathy for and coöperation with his scientific aims in the United States. In 1853, for instance, he had issued a circular, asking for collections of fishes from various fresh-water systems of the United States, in order that he might obtain certain data respecting the laws of their distribution and localization. To this he had hundreds of answers coming from all parts of the country, many of them very shrewd and observing, giving facts respecting the habits of fishes, as well as concerning their habitat, and offering aid in the general object. Nor were these empty promises. A great number and variety of collections, now making part of the ichthyological treasures of the Museum at Cambridge, were forwarded to him in answer to this appeal. Indeed, he now began to reap, in a new form, the harvest of his wandering lecture tours. In this part of his American experience he had come into contact with all classes of people, and had found

some of his most intelligent and sympathetic listeners in the working class. Now that he needed their assistance he often found his co-laborers among farmers, stock-raisers, sea-faring men, fishermen, and sailors. Many a New England captain, when he started on a cruise, had on board collecting cans, furnished by Agassiz, to be filled in distant ports or nearer home, as the case might be, and returned to the Museum at Cambridge. One or two letters, written to scientific friends at the time the above-mentioned circular was issued, will give an idea of the way in which Agassiz laid out such investigations.

TO JAMES D. DANA.

CAMBRIDGE, *July* 8, 1853.

. . . I have been lately devising some method of learning how far animals are truly autochthones, and how far they have extended their primitive boundaries. I will attempt to test that question with Long Island, the largest of all the islands along our coast. For this purpose I will for the present limit myself to the fresh-water fishes and shells, and for the sake of comparison I will try to collect carefully all the species living in the rivers of Connecticut, New York, and New Jersey, and

see whether they are identical with those of the island. Whatever may come out of such an investigation it will, at all events, furnish interesting data upon the local distribution of the species. . . . I am almost confident that it will lead to something interesting, for there is one feature of importance in the case; the present surface of Long Island is not older than the drift period; all its inhabitants must, therefore, have been introduced since that time. I shall see that I obtain similar collections from the upper course of the Connecticut, so as to ascertain whether there, as in the Mississippi, the species differ at different heights of the river basin. . . .

TO PROFESSOR S. S. HALDEMAN, COLUMBIA, PENNSYLVANIA.

CAMBRIDGE, *July* 9, 1853.

. . . While ascending the great Mississippi last spring I was struck with the remarkable fact that the fishes differ essentially in the different parts of that long water-course, — a fact I had already noticed in the Rhine, Rhone, and Danube, though there the difference arises chiefly from the occurrence, in the higher Alpine regions, of representatives of the trout family which are not found in the

main river course. In the Mississippi, however, the case is otherwise and very striking, inasmuch as we find here, at separate latitudes, distinct species of the same genera, somewhat like the differences observed in distinct water-basins; and yet the river is ever flowing on past these animals, which remain, as it were, spell-bound to the regions most genial to them. The question at once arises, do our smaller rivers present similar differences? I have already taken steps to obtain complete collections of fishes, shells, and crayfishes from various stations on the Connecticut and the Hudson, and their tributaries; and I should be very happy if I could include the Susquehanna, Delaware, and Ohio in my comparisons. My object in writing now is to inquire whether you could assist me in making separate collections, as complete as possible, of all these animals from the north and west branches of the Susquehanna, from the main river either at Harrisburg or Columbia, and from the Juniata, also from the Schuylkill, Lehigh, and Delaware, and from the Alleghany and Monongahela. I have Swiss friends in the State of New York who have promised me to collect the fishes from the head-waters of the Delaware and Susque-

hanna within the limits of the State of New York. I cannot, of course, expect you to survey your State for me, but among your acquaintance in various parts of your State are there not those who, with proper directions, could do the work for me? I would, of course, gladly repay all their expenses. The subject seems to me so important as to justify any effort in that direction. Little may be added to the knowledge of the fishes themselves, for I suppose most of the species have been described either by De Kay, Kirtland, or Storer; but a careful study of their special geographical distribution may furnish results as important to zoölogy as the knowledge of the species themselves. If you cannot write yourself, will you give me the names of such persons as might be persuaded to aid in the matter. I know from your own observations in former times that you have already collected similar facts for the Unios, so that you will at once understand and appreciate my object. . . .

He writes in the same strain and for the same object to Professor Yandell, of Kentucky, adding: "In this respect the State of Kentucky is one of the most important of the

Union, not only on account of the many rivers which pass through its territory, but also because it is one of the few States the fishes of which have been described by former observers, especially by Rafinesque in his "Ichthyologia Ohioensis," so that a special knowledge of all his original types is a matter of primary importance for any one who would compare the fishes of the different rivers of the West. . . . Do you know whether there is anything left of Rafinesque's collection of fishes in Lexington, and if so, whether the specimens are labeled, as it would be very important to identify his species from his own collection and his own labels? I never regretted more than now that circumstances have not yet allowed me to visit your State and make a stay in Louisville."

In 1854 Agassiz moved to a larger house, built for him by the college. Though very simple, it was on a liberal scale with respect to space; partly in order to accommodate his library, consisting of several thousand volumes, now for the first time collected and arranged in one room. He became very fond of this Cambridge home, where, with few absences, he spent the remainder of his life. The architect, Mr. Henry Greenough, was his

personal friend, and from the beginning the house adapted itself with a kindly readiness to whatever plans developed under its roof. As will be seen, these were not few, and were sometimes of considerable moment. For his work also the house was extremely convenient. His habits in this respect were, however, singularly independent of place and circumstance. Unlike most studious men, he had no fixed spot in the house for writing. Although the library, with the usual outfit of well-filled shelves, maps, large tables, etc., held his materials, he brought what he needed for the evening by preference to the drawing-room, and there, with his paper on his knee, and his books for reference on a chair beside him, he wrote and read as busily as if he were quite alone. Sometimes when dancing and music were going on among the young people of the family and their guests, he drew a little table into the corner of the room, and continued his occupations as undisturbed and engrossed as if he had been in complete solitude, — only looking up from time to time with a pleased smile or an apt remark, which showed that he did not lose but rather enjoyed what was going on about him.

His children's friends were his friends. As

his daughters grew up, he had the habit of inviting their more intimate companions to his library for an afternoon weekly. On these occasions there was always some subject connected with the study of nature under discussion, but the talk was so easy and so fully illustrated that it did not seem like a lesson. It is pleasant to remember that in later years Mr. Ralph Waldo Emerson revived this custom for his own daughters; and their friends (being, indeed, with few changes, the same set of young people as had formerly met in Agassiz's library) used to meet in Mr. Emerson's study at Concord for a similar object. He talked to them of poetry and literature and philosophy as Agassiz had talked to them of nature. Those were golden days, not to be forgotten by any who shared their happy privilege.

In the winter of 1855 Agassiz endeavored to resume his public lectures as a means of increasing his resources. He was again, however, much exhausted when spring came, and it seemed necessary to seek some other means of support, for without considering scientific expenses, his salary of fifteen hundred dollars did not suffice for the maintenance of his family. Under these circumstances it occurred

to his wife and his two older children, now of an age to assist her in such a scheme, that a school for young ladies might be established in the upper part of the new and larger house. By the removal of one or two partitions, ample room could be obtained for the accommodation of a sufficient number of pupils, and if successful such a school would perhaps make good in a pecuniary sense the lecturing tours which were not only a great fatigue to Agassiz, but an interruption also to all consecutive scientific work. In consultation with friends these plans were partly matured before they were confided to Agassiz himself. When the domestic conspirators revealed their plot, his surprise and pleasure knew no bounds. The first idea had been simply to establish a private school on the usual plan, only referring to his greater experience for advice and direction in its general organization. But he claimed at once an active share in the work. Under his inspiring influence the outline enlarged, and when the circular announcing the school was issued, it appeared under his name, and contained these words in addition to the programme of studies: "I shall myself superintend the methods of instruction and tuition, and while maintaining that regularity

and precision in the studies so important to mental training shall endeavor to prevent the necessary discipline from falling into a lifeless routine, alike deadening to the spirit of teacher and pupil. It is farther my intention to take the immediate charge of the instruction in Physical Geography, Natural History, and Botany, giving a lecture daily, Saturdays excepted, on one or other of these subjects, illustrated by specimens, models, maps, and drawings."

In order not to interrupt the course of the narrative, the history of this undertaking in its sequence and general bearing on his life and work may be completed here in a few words. This school secured to him many happy and comparatively tranquil years. It enabled him to meet both domestic and scientific expenses, and to pay the heavy debt he had brought from Europe as the penalty of his "Fossil Fishes" and his investigations on the glaciers. When the school closed after eight years he was again a free man. With an increased salary from the college, and with such provision for the Museum (thanks to the generosity of the State and of individuals) as rendered it in a great degree independent, he was never again involved in the pecuniary

anxieties of his earlier career. The occupation of teaching was so congenial to him that his part in the instruction of the school did not at any time weigh heavily upon him. He never had an audience more responsive and more eager to learn than the sixty or seventy girls who gathered every day at the close of the morning to hear his daily lecture; nor did he ever give to any audience lectures more carefully prepared, more comprehensive in their range of subjects, more lofty in their tone of thought. As a teacher he always discriminated between the special student, and the one to whom he cared to impart only such a knowledge of the facts of nature, as would make the world at least partially intelligible to him. To a school of young girls he did not think of teaching technical science, and yet the subjects of his lectures comprised very abstruse and comprehensive questions. It was the simplicity and clearness of his method which made them so interesting to his young listeners. "What I wish for you," he would say, "is a culture that is alive, active, susceptible of farther development. Do not think that I care to teach you this or the other special science. My instruction is only intended to show you the thoughts in nature which

science reveals, and the facts I give you are useful only, or chiefly, for this object."

Running over the titles of his courses during several consecutive years of this school instruction they read: Physical Geography and Paleontology; Zoölogy; Botany; Coral Reefs; Glaciers; Structure and Formation of Mountains; Geographical Distribution of Animals; Geological Succession of Animals; Growth and Development of Animals; Philosophy of Nature, etc. With the help of drawings, maps, bas-reliefs, specimens, and countless illustrations on the blackboard, these subjects were made clear to the pupils, and the lecture hour was anticipated as the brightest of the whole morning. It soon became a habit with friends and neighbors, and especially with the mothers of the scholars, to drop in for the lectures, and thus the school audience was increased by a small circle of older listeners. The corps of teachers was also gradually enlarged. The neighborhood of the university was a great advantage in this respect, and Agassiz had the coöperation not only of his brother-in-law, Professor Felton, but of others among his colleagues, who took classes in special departments, or gave lectures in history and literature.

This school opened in 1855 and closed in 1863. The civil war then engrossed all thoughts, and interfered somewhat also with the success of private undertakings. Partly on this account, partly also because it had ceased to be a pecuniary necessity, it seemed wise to give up the school at this time. The friendly relations formed there did not, however, cease with it. For years afterward on the last Thursday of June (the day of the annual closing of the school) a meeting of the old pupils was held at the Museum, which did not exist when the school began, but was fully established before its close. There Agassiz showed them the progress of his scientific work, told them of his future plans for the institution, and closed with a lecture such as he used to give them in their school-days. The last of these meetings took place in 1873, the last year of his own life. The memory of it is connected with a gift to the Museum of four thousand and fifty dollars from a number of the scholars, now no longer girls, but women with their own cares and responsibilities. Hearing that there was especial need of means for the care of the more recent collections, they had subscribed this sum among themselves to express their affection for their

old teacher, as well as their interest in his work, and in the institution he had founded. His letter of acknowledgment to the one among them who had acted as their treasurer makes a fitting close to this chapter.

. . . Hardly anything in my life has touched me more deeply than the gift I received this week from my school-girls. From no source in the world could sympathy be more genial to me. The money I shall appropriate to a long-cherished scheme of mine, a special work in the Museum which must be exclusively my own, — the arrangement of a special collection illustrating in a nutshell, as it were, all the relations existing among animals, — which I have deferred because other things were more pressing, and our means have been insufficient. The feeling that you are all working with me will be even more cheering than the material help, much needed as that is. I wish I could write to each individually. I shall try to find some means of expressing my thanks more widely. Meantime I write to you as treasurer, and beg you, as far as you can do so without too much trouble, to express my gratitude to others. Will you also say to those whom you chance to meet that I shall be at

the Museum on the last Thursday of June, at half-past eleven o'clock. I shall be delighted to see all to whom it is convenient to come. The Museum has grown not only in magnitude, but in scientific significance, and I like from time to time to give you an account of its progress, and of my own work and aims. How much thought and care and effort this kind plan of yours must have involved, scattered as you all are! It cannot have been easy to collect the names and addresses of all those whose signatures it was delightful to me to see again. Words seem to me very poor, but you will accept for yourself and your school-mates the warm thanks and affectionate regards of your old friend and teacher.

L. R. AGASSIZ.

CHAPTER XVIII.

1855 – 1860 : ÆT. 48 – 53.

"Contributions to Natural History of the United States." — Remarkable Subscription. — Review of the Work. — Its Reception in Europe and America. — Letters from Humboldt and Owen concerning it. — Birthday. — Longfellow's Verses. — Laboratory at Nahant. — Invitation to the Museum of Natural History in Paris. — Founding of Museum of Comparative Zoölogy in Cambridge. — Summer Vacation in Europe.

A FEW months earlier than the school circular Agassiz issued another prospectus, which had an even more important bearing upon his future work. This was the prospectus for his "Contributions to the Natural History of the United States." It was originally planned in ten volumes, every volume to be, however, absolutely independent, so that the completeness of each part should not be impaired by any possible interruption of the sequence. The mass of original material accumulated upon his hands ever since his arrival in America made such a publication almost imperative, but the costliness of a large illustrated work

deterred him. The "Poissons Fossiles" had shown him the peril of entering upon such an enterprise without capital. Perhaps he would never have dared to undertake it but for a friendly suggestion which opened a way out of his perplexities. Mr. Francis C. Gray, of Boston, who felt not only the interest of a personal friend in the matter, but also that of one who was himself a lover of letters and science, proposed an appeal to the public spirit of the country in behalf of a work devoted entirely to the Natural History of the United States. Mr. Gray assumed the direction of the business details, set the subscription afloat, stimulated its success by his own liberal contributions, by letters, by private and public appeals. The result far exceeded the most sanguine expectations of those interested in its success. Indeed, considering the purely scientific character of the work, the number of subscribers for it was extraordinary, and showed again the hold Agassiz had taken upon the minds and affections of the people in general. The contributors were by no means confined to Boston and Cambridge, although the Massachusetts list was naturally the largest, nor were they found exclusively among literary and scientific circles. On the contrary,

the subscription list, to the astonishment of the publishers, was increased daily by unsolicited names, sent in from all sections of the country, and from various grades of life and occupation. In reference to the character of this subscription Agassiz says in his Preface: "I must beg my European readers to remember that this work is written in America, and more especially for Americans; and that the community to which it is particularly addressed has very different wants from those of the reading public in Europe. There is not a class of learned men here distinct from the other cultivated members of the community. On the contrary, so general is the desire for knowledge, that I expect to see my book read by operatives, by fishermen, by farmers, quite as extensively as by the students in our colleges or by the learned professions, and it is but proper that I should endeavor to make myself understood by all." If Agassiz, perhaps, overestimated in this statement the appreciation of the reading public in the United States for pure scientific research, it was because the number and variety of his subscribers gave evidence of a cordiality toward his work which surprised as much as it gratified him. On the list there were also some of his old European

subscribers to the "Poissons Fossiles," among them the King of Prussia, who still continued, under the influence of Humboldt, to feel an interest in his work.

FROM HUMBOLDT TO AGASSIZ.

September 1, 1856.

. . . I hear that by some untoward circumstances, no doubt accidental, you have never received, my dear Agassiz, the letter expressing the pleasure which I share with all true lovers of science respecting your important undertaking, "Contributions to the Natural History of the United States." You must have been astonished at my silence, remembering, not only the affectionate relations we have held to each other ever since your first sojourn at Paris, but also the admiration I have never ceased to feel for the great and solid works which we owe to your sagacious mind and your incomparable intellectual energy. . . . I approve especially the general conceptions which lie at the base of the plan you have traced. I admire the long series of physiological investigations, beginning with the embryology of the so-called simple and lower organisms and ascending by degrees to the more complicated. I admire that ever-renewed

comparison of the types belonging to our planet, in its present condition, with those now found only in a fossil state, so abundant in the immense space lying between the shores opposite to northern Europe and northern Asia. The geographical distribution of organic forms in curves of equal density of occupation represents in great degree the inflexions of the isothermal lines. . . . I am charged by the king, who knows the value of your older works, and who still feels for you the affectionate regard which he formerly expressed in person, to request that you will place his name at the head of your long list of subscribers. He wishes that an excursion across the Atlantic valley may one day bring you, who have so courageously braved Alpine summits, to the historic hill of Sans Souci. . . .

Something of Agassiz's astonishment and pleasure at the encouragement given to his projected work is told in his letters. To his old friend Professor Valenciennes, in Paris, he writes: "I have just had an evidence of what one may do here in the interest of science. Some six months ago I formed a plan for the publication of my researches in America, and determined to carry it out with all

possible care and beauty of finish. I estimated my materials at ten volumes, quarto, and having fixed the price at 60 francs ($12.00) a volume, thought I might, perhaps, dispose of five hundred. I brought out my prospectus, and I have to-day seventeen hundred subscribers. What do you say to that for a work which is to cost six hundred francs a copy, and of which nothing has as yet appeared? Nor is the list closed yet, for every day I receive new subscriptions, — this very morning one from California! Where will not the love of science find its niche!" . . .

In the same strain he says, at a little later date, to Sir Charles Lyell: "You will, no doubt, be pleased to learn that the first volume of my new work, 'Contributions to the Natural History of the United States,' which is to consist of ten volumes, quarto, is now printing, to come out this summer. I hope it will show that I have not been idle during ten years' silence. I am somewhat anxious about the reception of my first chapter, headed, 'Classification,' which contains anything but what zoölogists would generally expect under that head. The subscription is marvelous. Conceive twenty-one hundred names before the appearance of the first pages of a work

costing one hundred and twenty dollars! It places in my hands the means of doing henceforth for Natural History what I had never dreamed of before." . . .

This work, as originally planned, was never completed. It was cut short by ill-health and by the pressure of engagements arising from the rapid development of the great Museum, which finally became, as will be seen, the absorbing interest of his life. As it stands, the "Contributions to the Natural History of the United States" consists of four large quarto volumes. The first two are divided into three parts, namely: 1st. An Essay on Classification. 2d. The North American Testudinata. 3d. The Embryology of the Turtle, — the latter two being illustrated by thirty-four plates. The third and fourth volumes are devoted to the Radiata, and consist of five parts, namely: 1st. Acalephs in general. 2d. Ctenophoræ. 3d. Discophoræ. 4th. Hydroida. 5th. Homologies of the Radiates, — illustrated by forty-six plates.[1]

[1] The plates are of rare accuracy and beauty, and were chiefly drawn by A. Sonrel, though many of the microscopic drawings were made by Professor H. J. Clark, who was at that time Agassiz's private assistant. For details respecting Professor Clark's share in this work, and also concerning the aid of various kinds furnished to the author during its prep-

For originality of material, clearness of presentation, and beauty of illustration, these volumes have had their full recognition as models of scientific work. Their philosophy was, perhaps, too much out of harmony with the current theories of the day to be acceptable. In the "Essay on Classification" especially, Agassiz brought out with renewed earnestness his conviction that the animal world rests upon certain abstract conceptions, persistent and indestructible. He insists that while physical influences maintain, and within certain limits modify, organisms, they have never affected typical structure, — those characters, namely, upon which the great groups of the animal kingdom are united. From his point of view, therefore, what environment can do serves to emphasize what it cannot do. For the argument on which these conclusions are based we refer to the book itself. The discussion of this question occupies, however, only the first portion of the volume, two thirds of which are devoted to a general consideration of classification, and the ideas which it embodies, with a review of the modern systems of zoölogy.

aration, the reader is referred to the Preface of the volumes themselves.

The following letter was one of many in the same tone received from his European correspondents concerning this work.

FROM RICHARD OWEN.

December 9, 1857.

. . . I cannot permit a day to elapse without thanking you for the two volumes of your great work on American zoölogy, which, from your masterly and exhaustive style of treatment, becomes the most important contribution to the right progress of zoölogical science in all parts of the world where progress permits its cultivation. It is worthy of the author of the classical work on fossil fishes; and such works, like the Cyclopean structures of antiquity, are built to endure. I feel and I beg to express a fervent hope that you may be spared in health and vigor to see the completion of your great plan.

I have placed in Mr. Trübner's hands a set of the numbers (6) of my "History of British Fossil Reptiles," which have already appeared; a seventh will soon be out, and as they will be sent to you in succession I hope you will permit me to make a small and inadequate return for your liberality in the gift of your work

by adding your name to the list of my subscribers. . . .

Believe me always truly yours,

RICHARD OWEN.

Agassiz had promised himself that the first volume of his new work should be finished in time for his fiftieth birthday, — a milestone along the road, as it were, to mark his half century. Upon this self-appointed task he spent himself with the passion dominated by patience, which characterized him when his whole heart was bent toward an end. For weeks he wrote many hours of the day and a great part of the night, going out sometimes into the darkness and the open air to cool the fever of work, and then returning to his desk again. He felt himself that the excitement was too great, and in proportion to the strain was the relief when he set the seal of *finis* on his last page within the appointed time.

His special students, young men who fully shared his scientific life and rewarded his generosity by an affectionate devotion, knowing, perhaps, that he himself associated the completion of his book with his birthday, celebrated both events by a serenade on the eve of his anniversary. They took into their con-

fidence Mr. Otto Dresel, warmly valued by Agassiz both as friend and musician, and he arranged their midnight programme for them. Always sure of finding their professor awake and at work at that hour, they stationed the musicians before the house, and as the last stroke of twelve sounded, the succeeding stillness was broken by men's voices singing a Bach choral. When Agassiz stepped out to see whence came this pleasant salutation, he was met by his young friends bringing flowers and congratulations. Then followed one number after another of the well-ordered selection, into which was admitted here and there a German student song in memory of Agassiz's own university life at Heidelberg and Munich. It was late, or rather early, since the new day was already begun, before the little concert was over and the guests had dispersed. It is difficult to reproduce with anything like its original glow and coloring a scene of this kind. It will no more be called back than the hour or the moonlight night which had the warmth and softness of June. It is recorded here only because it illustrates the intimate personal sympathy between Agassiz and his students.

For this occasion also were written the well-

known birthday verses by Longfellow, which were read the next day at a dinner given to Agassiz by the "Saturday Club." In speaking of Longfellow's relation to this club, Holmes says: "On one occasion he read a short poem at the table. It was in honor of Agassiz's birthday, and I cannot forget the very modest, delicate musical way in which he read his charming verses." Although included in many collections of Longfellow's Poems, they are reproduced here, because the story seems incomplete without them.

THE FIFTIETH BIRTHDAY OF AGASSIZ.

It was fifty years ago,
In the pleasant month of May,
In the beautiful Pays de Vaud,
A child in its cradle lay.

And Nature, the old nurse, took
The child upon her knee,
Saying: "Here is a story-book
Thy Father has written for thee."

"Come wander with me," she said,
"Into regions yet untrod;
And read what is still unread
In the manuscripts of God."

And he wandered away and away
With Nature, the dear old nurse,

Who sang to him night and day
The rhymes of the universe.

And whenever the way seemed long,
Or his heart began to fail,
She would sing a more wonderful song,
Or tell a more marvelous tale.

So she keeps him still a child,
And will not let him go,
Though at times his heart beats wild
For the beautiful Pays de Vaud;

Though at times he hears in his dreams
The Ranz des Vaches of old,
And the rush of mountain streams
From glaciers clear and cold;

And the mother at home says, "Hark!
For his voice I listen and yearn;
It is growing late and dark,
And my boy does not return!"

May 28, 1857.

Longfellow had an exquisite touch for occasions of this kind, whether serious or mirthful. Once, when some years after this Agassiz was keeping Christmas Eve with his children and grandchildren, there arrived a basket of wine containing six old bottles of rare vintage. They introduced themselves in a charming French "Noel" as pilgrims from beyond

the sea who came to give Christmas greeting to the master of the house. Gay pilgrims were these six "gaillards," and they were accompanied by the following note: —

"A Merry Christmas and Happy New Year to all the house of Agassiz!

"I send also six good wishes in the shape of bottles. Or is it wine?

"It is both; good wine and good wishes, and kind memories of you on this Christmas Eve." H. W. L.

An additional word about the "Saturday Club," the fame of which has spread beyond the city of its origin, may not be amiss here. Notwithstanding his close habits of work Agassiz was eminently social, and to this club he was especially attached. Dr. Holmes says of it in his volume on Emerson, who was one of its most constant members: "At one end of the table sat Longfellow, florid, quiet, benignant, soft-voiced, a most agreeable rather than a brilliant talker, but a man upon whom it was always pleasant to look, — whose silence was better than many another man's conversation. At the other end sat Agassiz, robust, sanguine, animated, full of talk, boy-like in his laughter. The stranger who should have asked who were the men ranged along the sides of the table

would have heard in answer the names of Hawthorne, Motley, Dana, Lowell, Whipple, Peirce, the distinguished mathematician, Judge Hoar, eminent at the bar and in the cabinet, Dwight, the leading musical critic of Boston for a whole generation, Sumner, the academic champion of freedom, Andrew, 'the great War Governor' of Massachusetts, Dr. Howe, the philanthropist, William Hunt, the painter, with others not unworthy of such company." We may complete the list and add the name of Holmes himself, to whose presence the club owed so much of its wit and wisdom. In such company the guests were tempted to linger long, and if Holmes has described the circle around the table, Lowell has celebrated the late walk at night across the bridge as he and Agassiz returned to Cambridge on foot together. To break the verse by quotation would mar the quiet scene and interrupt the rambling pleasant talk it so graphically describes. But we may keep the parting words:

"At last, arrived at where our paths divide,
'Good night!' and, ere the distance grew too wide,
'Good night!' again; and now with cheated ear
I half hear his who mine shall never hear." [1]

[1] See Memorial poem, entitled *Agassiz*, by James Russell Lowell.

Agassiz was now the possessor of a small laboratory by the immediate sea-coast. It was situated on the northeastern shore of Nahant, within a stone's throw of broken and bold rocks, where the deep pools furnished him with ever fresh specimens from natural aquariums which were re-stocked at every rise of the tide. This laboratory, with a small cottage adjoining, which was shared during the summer between his own family and that of Professor Felton, was the gift of his father-in-law, Mr. Cary. So carefully were his wishes considered that the microscope table stood on a flat rock sunk in the earth and detached from the floor, in order that no footstep or accidental jarring of door or window in other parts of the building might disturb him at his work.

There, summer after summer, he pursued his researches on the medusæ; from the smaller and more exquisite kinds, such as the Pleurobrachyias, Idyias, and Bolinas, to the massive Cyaneas, with their large disks and heavy tentacles, many yards in length. Nothing can be prettier than the smaller kinds of jelly-fishes. Their structure is so delicate, yet so clearly defined, their color so soft, yet often so brilliant, their texture so transparent, that

COTTAGE AT NAHANT

you seek in vain among terrestrial forms for terms of comparison, and are tempted to say that nature has done her finest work in the sea rather than on land. Sometimes hundreds of these smaller medusæ might be seen floating together in the deep glass bowls, or jars, or larger vessels with which Agassiz's laboratory at Nahant was furnished. When the supply was exhausted, new specimens were easily to be obtained by a row in a dory a mile or two from shore, either in the hot, still noon, when the jelly-fish rise toward the surface, or at night, over a brilliantly phosphorescent sea, when they are sure to be abundant, since they themselves furnish much of the phosphorescence. In these little excursions, many new and interesting things came to his nets beside those he was seeking. The fishermen, also, were his friends and coadjutors. They never failed to bring him whatever of rare or curious fell into their hands, sometimes even turning aside from their professional calling to give the laboratory preference over the market.

Neither was his summer work necessarily suspended during winter, his Cambridge and Nahant homes being only about fifteen miles distant from each other. He writes to his

friends, the Holbrooks, at this time, "You can hardly imagine what a delightful place Nahant is for me now. I can trace the growth of my little marine animals all the year round without interruption, by going occasionally over there during the winter. I have at this moment young medusæ budding from their polyp nurses, which I expect to see freeing themselves in a few weeks." In later years, when his investigations on the medusæ were concluded, so far as any teaching from the open book of Nature can be said to be concluded, he pursued here, during a number of years, investigations upon the sharks and skates. For this work, which should have made one of the series of "Contributions," he left much material, unhappily not ready for publication.

In August, 1857, Agassiz received the following letter from M. Rouland, Minister of Public Instruction in France.

TO PROFESSOR AGASSIZ.

PARIS, *August* 19, 1857.

SIR, — By the decease of M. d'Orbigny the chair of paleontology in the Museum of Natural History in Paris becomes vacant. You are French; you have enriched your native country by your eminent works and laborious

researches. You are a corresponding member of the Institute. The emperor would gladly recall to France a savant so distinguished. In his name I offer you the vacant chair, and should congratulate your country on the return of a son who has shown himself capable of such devotion to science.

Accept the assurance of my highest esteem,

ROULAND.

Had it been told to Agassiz when he left Europe that in ten years he should be recalled to fill one of the coveted places at the Jardin des Plantes, the great centre of scientific life and influence in France, he would hardly have believed himself capable of refusing it. Nor does a man reject what would once have seemed to him a great boon without a certain regret. Such momentary regret he felt perhaps, but not an instant of doubt. His answer expressed his gratitude and his pleasure in finding himself so remembered in Europe. He pleaded his work in America as his excuse for declining a position which he nevertheless considered the most brilliant that could be offered to a naturalist. In conclusion he adds: "Permit me to correct an error concerning myself. I am not French, although of French

origin. My family has been Swiss for centuries, and spite of my ten years' exile I am Swiss still."

The correspondence did not end here. A few months later the offer was courteously renewed by M. Rouland, with the express condition that the place should remain open for one or even two years to allow time for the completion of the work Agassiz had now on hand. To this second appeal he could only answer that his work here was the work not of years, but of his life, and once more decline the offer. That his refusal was taken in good part is evident from the fact that the order of the Legion of Honor was sent to him soon after, and that from time to time he received friendly letters from the Minister of Public Instruction, who occasionally consulted him upon general questions of scientific moment.

This invitation excited a good deal of interest among Agassiz's old friends in Europe. Some urged him to accept it, others applauded his resolve to remain out of the great arena of competition and ambition. Among the latter was Humboldt. The following extract is from a letter of his (May 9, 1858) to Mr. George Ticknor, of Boston, who had been one of Agassiz's kindest and best friends in Amer

ica from the moment of his arrival. "Agassiz's large and beautiful work (the first two volumes) reached me a few days since. It will produce a great effect both by the breadth of its general views and by the extreme sagacity of its special embryological observations. I have never believed that this illustrious man, who is also a man of warm heart, a noble soul, would accept the generous offers made to him from Paris. I knew that gratitude would keep him in the new country, where he finds such an immense territory to explore, and such liberal aid in his work."

In writing of this offer to a friend Agassiz himself says: "On one side, my cottage at Nahant by the sea-shore, the reef of Florida, the vessels of the Coast Survey at my command from Nova Scotia to Mexico, and, if I choose, all along the coast of the Pacific, — and on the other, the Jardin des Plantes, with all its accumulated treasures. Rightly considered, the chance of studying nature must prevail over the attractions of the (Paris) Museum. I hope I shall be wise enough not to be tempted even by the prospect of a new edition of the 'Poissons Fossiles.'"

To his old friend Charles Martins, the naturalist, he writes: "The work I have under-

taken here, and the confidence shown in me by those who have at heart the intellectual development of this country, make my return to Europe impossible for the present; and, as you have well understood, I prefer to build anew here rather than to fight my way in the midst of the coteries of Paris. Were I offered absolute power for the reorganization of the Jardin des Plantes, with a revenue of fifty thousand francs, I should not accept it. I like my independence better."

The fact that Agassiz had received and declined this offer from the French government seemed to arouse anew the public interest in his projects and prospects here. It was felt that a man who was ready to make an alliance so uncompromising with the interests of science in the United States should not be left in a precarious and difficult position. His collections were still heaped together in a slight wooden building. The fact that a great part of them were preserved in alcohol made them especially in danger from fire. A spark, a match carelessly thrown down, might destroy them all in half an hour, for with material so combustible, help would be unavailing. This fear was never out of his mind. It disturbed his peace by day and his

rest by night. That frail structure, crowded from garret to cellar with seeming rubbish, with boxes, cases, barrels, casks still unpacked and piled one above the other, held for him the treasure out of which he would give form and substance to the dream of his boyhood and the maturer purpose of his manhood. The hope of creating a great museum intelligently related in all its parts, reflecting nature, and illustrating the history of the animal kingdom in the past and the present, had always tempted his imagination. Nor was it merely as a comprehensive and orderly collection that he thought of it. From an educational point of view it had an even greater value for him. His love of teaching prompted him no less than his love of science. Indeed, he hoped to make his ideal museum a powerful auxiliary in the interests of the schools and teachers throughout the State, and less directly throughout the country. He hoped it would become one of the centres for the radiation of knowledge, and that the investigations carried on within its walls would find means of publication, and be a fresh, original contribution to the science of the day. This hope was fully realized. The first number of the Museum Bulletin was published in March,

1863, the first number of the Illustrated Catalogue in 1864, and both publications have been continued with regularity ever since.[1]

In laying out the general plan, which was rarely absent from his thought, he distinguished between the demands which the specialist and the general observer might make upon an institution intended to instruct and benefit both. Here the special student should find in the laboratories and work rooms all the needed material for his investigations, stored in large collections, with duplicates enough to allow for that destruction of specimens which is necessarily involved in original research. The casual visitor meanwhile should walk through exhibition rooms, not simply crowded with objects to delight and interest him, but so arranged that the selection of every specimen should have reference to its part and place in nature; while the whole should be so combined as to explain, so far as known, the faunal and systematic relations of animals in the actual world, and in the geological formations; or, in other words, their succession in time, and their distribution in space.

[1] At the time of Agassiz's death nearly three volumes of the Bulletin had been published, and the third volume of the *Memoirs* (Illustrated Catalogue, No. 7) had been begun.

A favorite part of his plan was a room which he liked to call his synoptic room. Here was to be the most compact and yet the fullest statement in material form of the animal kingdom as a whole, an epitome of the creation, as it were. Of course the specimens must be few in so limited a space, but each one was to be characteristic of one or other of the various groups included under every large division. Thus each object would contribute to the explanation of the general plan. On the walls there were to be large, legible inscriptions, serving as a guide to the whole, and making this room a simple but comprehensive lesson in natural history. It was intended to be the entrance room for visitors, and to serve as an introduction to the more detailed presentation of the same vast subject, given by the faunal and systematic collections in the other exhibition rooms.

The standard of work involved in this scheme is shown in many of his letters to his students and assistants, to whom he looked for aid in its execution. To one he writes: "You will get your synoptic series only after you have worked up in detail the systematic collection as a whole, the faunal collections in their totality, the geological sequence of the

entire group under consideration, as well as its embryology and geographical distribution. Then alone will you be able to know the representatives in each series which will best throw light upon it and complete the other series."

He did not live to fill in this comprehensive outline with the completeness which he intended, but all its details were fully explained by him before his death, and since that time have been carried out by his son, Alexander Agassiz. The synoptic room, and in great part the systematic and faunal collections, are now arranged and under exhibition, and the throngs of visitors during all the pleasant months of the year attest the interest they excite.

This conception, of which the present Museum is the expression, was matured in the brain of the founder before a brick of the building was laid, or a dollar provided for the support of such an institution. It existed for him as his picture does for the artist before it lives upon the canvas. One must have been the intimate companion of his thoughts to know how and to what degree it possessed his imagination, to his delight always, yet sometimes to his sorrow also, for he had it and he

had it not. The thought alone was his; the means of execution were far beyond his reach.

His plan was, however, known to many of his friends, and especially he had explained it to Mr. Francis C. Gray, whose intellectual sympathy made him a delightful listener to the presentation of any enlightened purpose. In 1858 Mr. Gray died, leaving in his will the sum of fifty thousand dollars for the establishment of a Museum of Comparative Zoölogy, with the condition that this sum should be used neither for the erection of buildings nor for salaries, but for the purely scientific needs of such an institution. Though this bequest was not connected in set terms with the collections already existing in Cambridge, its purpose was well understood; and Mr. Gray's nephew, Mr. William Gray, acting upon the intention of his uncle as residuary legatee, gave it into the hands of the President and Fellows of Harvard University. In passing over this trust, the following condition, among others, was made, namely: "That neither the collections nor any building which may contain the same shall ever be designated by any other name than the Museum of Comparative Zoölogy at Harvard." This is worth noting, because the title was chosen and in-

sisted upon by Agassiz himself in opposition to many who would have had it called after him. To such honor as might be found in connecting his own name with a public undertaking of any kind he was absolutely indifferent. It was characteristic of him to wish, on the contrary, that the name should be as impersonal and as comprehensive as the uses and aims of the institution itself. Yet he could not wholly escape the distinction he deprecated. The popular imagination, identifying him with his work, has re-christened the institution; and, spite of its legal title, its familiar designation is almost invariably the "Agassiz Museum."

Mr. Gray's legacy started a movement which became every day more active and successful. The university followed up his bequest by a grant of land suitable for the site of the building, and since the Gray fund provided for no edifice, an appeal was made to the Legislature of Massachusetts to make good that deficiency. The Legislature granted lands to the amount of one hundred thousand dollars, on condition that a certain additional contribution should be made by private subscription. The sum of seventy-one thousand one hundred and twenty-five dollars, somewhat exceed-

MUSEUM OF COMPARATIVE ZOÖLOGY.

ing that stipulated, was promptly subscribed, chiefly by citizens of Boston and Cambridge, and Agassiz himself gave all the collections he had brought together during the last four or five years, estimated, merely by the outlay made upon them, at ten thousand dollars. The architects, Mr. Henry Greenough and Mr. George Snell, offered the plan as their contribution. The former had long been familiar with Agassiz's views respecting the internal arrangements of the building. The main features had been discussed between them, and now, that the opportunity offered, the plan was practically ready for execution. These events followed each other so rapidly that although Mr. Gray's bequest was announced only in December, 1858, the first sod was turned and the corner-stone of the future Museum was laid on a sunny afternoon in the following June, 1859.[1]

[1] The plan, made with reference to the future increase as well as the present needs of the Museum, included a main building 364 feet in length by 64 in width, with wings 205 feet in length by 64 in width, the whole enclosing a hollow square. The structure erected 1859–60 was but a section of the north wing, being two fifths of its whole length. This gave ample space at the time for the immediate requirements of the Museum. Additions have since been made, and the north wing is completed, while the Peabody Museum occupies a portion of the ground allotted to the south wing.

This event, so full of significance for Agassiz, took place a few days before he sailed for Europe, having determined to devote the few weeks of the college and school vacation to a flying visit in Switzerland. The incidents of this visit were of a wholly domestic nature and hardly belong here. He paused a few days in Ireland and England to see his old friends, the Earl of Enniskillen and Sir Philip Egerton, and review their collections. A day or two in London gave him, in like manner, a few hours at the British Museum, a day with Owen at Richmond, and an opportunity to greet old friends and colleagues called together to meet him at Sir Roderick Murchison's. He allowed himself also a week in Paris, made delightful by the cordiality and hospitality of the professors of the Jardin des Plantes, and by the welcome he received at the Academy, when he made his appearance there. The happiest hours of this brief sojourn in Paris were perhaps spent with his old and dear friend Valenciennes, the associate of earlier days in Paris, when the presence of Cuvier and Humboldt gave a crowning interest to scientific work there.

From Paris he hastened on to his mother in Switzerland, devoting to her and to his imme-

diate family all the time which remained to him before returning to his duties in Cambridge. They were very happy weeks, passed, for the most part, in absolute retirement, at Montagny, near the foot of the Jura, where Madame Agassiz was then residing with her daughter. The days were chiefly spent in an old-fashioned garden, where a corner shut in by ivy and shaded by trees made a pleasant out-of-door sitting-room. There he told his mother, as he had never been able to tell her in letters, of his life and home in the United States, and of the Museum to which he was returning, and which was to give him the means of doing for the study of nature all he had ever hoped to accomplish. His quiet stay here was interrupted only by a visit of a few days to his sister at Lausanne, and a trip to the Diablerets, where his brother, then a great invalid, was staying. He also passed a day or two at Geneva, where he was called to a meeting of the Helvetic Society, which gave him an opportunity of renewing old ties of friendship, as well as scientific relations, with the naturalists of his own country, with Pictet de la Rive, de Candolle, Favre, and others.

CHAPTER XIX.

1860–1863: ÆT. 53–56.

Return to Cambridge. — Removal of Collection to New Museum Building. — Distribution of Work. — Relations with his Students. — Breaking out of the War between North and South. — Interest of Agassiz in the Preservation of the Union. — Commencement of Museum Publications. — Reception of Third and Fourth Volumes of "Contributions." — Copley Medal. — General Correspondence. — Lecturing Tour in the West. — Circular Letter concerning Anthropological Collections. — Letter to Mr. Ticknor concerning Geographical Distribution of Fishes in Spain.

On his return to Cambridge at the end of September, Agassiz found the Museum building well advanced. It was completed in the course of the next year, and the dedication took place on the 13th November, 1860. The transfer of the collections to their new and safe abode was made as rapidly as possible, and the work of developing the institution under these more favorable conditions moved steadily on. The lecture rooms were at once opened, not only to students but to other persons not connected with the university. Especially welcome were teachers of schools

for whom admittance was free. It was a great pleasure to Agassiz thus to renew and strengthen his connection with the teachers of the State, with whom, from the time of his arrival in this country, he had held most cordial relations, attending the Teachers' Institutes, visiting the normal schools, and associating himself actively, as far as he could, with the interests of public education in Massachusetts. From this time forward his college lectures were open to women as well as to men. He had great sympathy with the desire of women for larger and more various fields of study and work, and a certain number of women have always been employed as assistants at the Museum.

The story of the next three years was one of unceasing but seemingly uneventful work. The daylight hours from nine or ten o'clock in the morning were spent, with the exception of the hour devoted to the school, at the Museum, not only in personal researches and in lecturing, but in organizing, distributing, and superintending the work of the laboratories, all of which was directed by him. Passing from bench to bench, from table to table, with a suggestion here, a kindly but scrutinizing glance there, he made his sympathetic pres-

ence felt by the whole establishment. No man ever exercised a more genial personal influence over his students and assistants. His initiatory steps in teaching special students of natural history were not a little discouraging. Observation and comparison being in his opinion the intellectual tools most indispensable to the naturalist, his first lesson was one in *looking*. He gave no assistance; he simply left his student with the specimen, telling him to use his eyes diligently, and report upon what he saw. He returned from time to time to inquire after the beginner's progress, but he never asked him a leading question, never pointed out a single feature of the structure, never prompted an inference or a conclusion. This process lasted sometimes for days, the professor requiring the pupil not only to distinguish the various parts of the animal, but to detect also the relation of these details to more general typical features. His students still retain amusing reminiscences of their despair when thus confronted with their single specimen; no aid to be had from outside until they had wrung from it the secret of its structure. But all of them have recognized the fact that this one lesson in looking, which forced them to such careful scrutiny of the

object before them, influenced all their subsequent habits of observation, whatever field they might choose for their special subject of study. One of them who was intending to be an entomologist concludes a very clever and entertaining account of such a first lesson, entirely devoted to a single fish, with these words: "This was the best entomological lesson I ever had, — a lesson whose influence has extended to the details of every subsequent study; a legacy the professor has left to me, as he left it to many others, of inestimable value, which we could not buy, with which we could not part." [1]

But if Agassiz, in order to develop independence and accuracy of observation, threw his students on their own resources at first, there was never a more generous teacher in the end than he. All his intellectual capital was thrown open to his pupils. His original material, his unpublished investigations, his most precious specimens, his drawings and illustrations were at their command. This liberality led in itself to a serviceable training, for he taught them to use with respect the valuable, often unique, objects intrusted to their care. Out of the intellectual good-fel-

[1] *In the Laboratory with Agassiz*, by S. H. Scudder.

lowship which he established and encouraged in the laboratory grew the warmest relations between his students and himself. Many of them were deeply attached to him, and he was extremely dependent upon their sympathy and affection. By some among them he will never be forgotten. He is still their teacher and their friend, scarcely more absent from their work now than when the glow of his enthusiasm made itself felt in his personal presence.

But to return to the distribution of his time in these busy days. Having passed, as we have seen, the greater part of the day in the Museum and the school, he had the hours of the night for writing, and rarely left his desk before one or two o'clock in the morning, or even later. His last two volumes of the "Contributions," upon the Acalephs, were completed during these years. In the mean time, the war between North and South had broken out, and no American cared more than he for the preservation of the Union and the institutions it represented. He felt that the task of those who served letters and science was to hold together the intellectual aims and resources of the country during this struggle for national existence, to fortify the strong

holds of learning, abating nothing of their efficiency, but keeping their armories bright against the return of peace, when the better weapons of civilization should again be in force. Toward this end he worked with renewed ardor, and while his friends urged him to suspend operations at the Museum and husband his resources until the storm should have passed over, he, on the contrary, stimulated its progress by every means in his power. Occasionally he was assisted by the Legislature, and early in this period an additional grant of ten thousand dollars was made to the Museum. With this grant was begun the series of illustrated publications already mentioned, known as the "Bulletin of the Museum of Comparative Zoölogy in Cambridge."

During this period he urged also the foundation of a National Academy of Sciences, and was active in furthering its organization and incorporation (1863) by Congress. With respect to this effort, and to those he was at the same time making for the Museum, he was wont to recall the history of the University of Berlin. In an appeal to the people in behalf of the intellectual institutions of the United States during the early years of the war he says: "A well known fact in the his-

tory of Germany has shown that the moment of political danger may be that in which the firmest foundations for the intellectual strength of a country may be laid. When in 1806, after the battle of Jena, the Prussian monarchy had been crushed and the king was despairing even of the existence of his realm, he planned the foundation of the University of Berlin, by the advice of Fichte, the philosopher. It was inaugurated the very year that the despondent monarch returned to his capital. Since that time it has been the greatest glory of the Prussian crown, and has made Berlin the intellectual centre of Germany."

It may be added here as an evidence of Agassiz's faith in the institutions of the United States and in her intellectual progress that he was himself naturalized in the darkest hour of the war, when the final disruption of the country was confidently prophesied by her enemies. By formally becoming a citizen of the United States he desired to attest his personal confidence in the stability of her Constitution and the justice of her cause.

Some light is thrown upon the work and incidents of these years by the following letters: —

FROM SIR PHILIP DE GREY EGERTON.

LONDON, ALBEMARLE ST., *April* 16, 1861.

MON CHER AGASS.,[1] — I have this morning received your handsome and welcome present of the third volume of your great undertaking, and this reminds me how remiss I have been in not writing to you sooner. In fact, I have had nothing worth writing about, and I know your time is too valuable to be intrenched upon by letters of mere gossip. I have not of course had time to peruse any portion of the monograph, but I have turned over the pages and seen quite enough to sharpen my appetite for the glorious scientific feast you have so liberally provided. And now that the weight is off your mind, I hope shortly to hear that you are about to fulfill this year the promise you made of returning to England for a good long visit, only postponed by circumstances you could not have foreseen. Now that you have your son as the sharer of your labors, you will be able to leave him in charge during your absence, and so divest your mind of all care and anxiety with reference to matters over the water. Here we are all fighting most furiously about Celts and flint imple-

[1] An affectionate abbreviation which Sir Philip often used for him.

ments, struggle for life, natural selection, the age of the world, races of men, biblical dates, apes, and gorillas, etc., and the last duel has been between Owen and Huxley on the anatomical distinction of the pithecoid brain compared with that of man. Theological controversy has also been rife, stirred up by the "Essays and Reviews," of which you have no doubt heard much. For myself, I have been busy preparing, in conjunction with Huxley, another decade of fossil fishes, all from the old red of Scotland. . . . Enniskillen is quite well. He is now at Lyme Regis. . . .

At about this time the Copley Medal was awarded to Agassiz, a distinction which was the subject of cordial congratulation from his English friends.

FROM SIR RODERICK MURCHISON.

BELGRAVE SQUARE, *March*, 1862.

MY DEAR AGASSIZ, — Your letter of the 14th February was a great surprise to me. I blamed myself for not writing you sooner than I did on the event which I had long been anxious to see realized; but I took it for granted that you had long before received the official announcement from the foreign secre-

tary that you were, at the last anniversary of the Royal Society, the recipient of the highest honor which our body can bestow, whether on a foreigner or a native. . . . On going to the Royal Society to-day I found that the President and Secretaries were much surprised that you had never answered the official letter sent to you on the 1st or 2d December by the Foreign Secretary, Professor Müller, of Cambridge. He wrote to announce the award, and told you the Copley Medal was in his safe keeping till you wrote to say what you wished to have done with it. I have now recommended him to transmit it officially to you through the United States Minister, Mr. Adams. In these times of irritation, everything which soothes and calms down angry feelings ought to be resorted to; and I hope it may be publicly known that when our newspapers were reciprocating all sorts of rudenesses, the men of science of England thought of nothing but honoring a beloved and eminent savant of America.

I thank you for your clear and manly view of the North and South, which I shall show to all our mutual friends. Egerton, who is now here, was delighted to hear of you, as well as Huxley, Lyell, and many others. . . .

In a paper just read to the Geological Society Professor Ramsay has made a stronger demand on the powers of ice than you ever did. He imagines that every Swiss lake north and south (Geneva, Neuchâtel, Como, etc.) has been scooped out, and the depressions excavated by the abrading action of the glaciers. . . .

FROM SIR PHILIP DE GREY EGERTON.

ALBEMARLE ST., LONDON, *March* 11, 1862.

MON CHER AGASS., — As I am now settled in London for some months, I take the first opportunity of writing to congratulate you on the distinction which has been conferred upon you by the Royal Society, and I will say that you have most fully earned it. I rejoice exceedingly in the decision the Council have arrived at. I only regret I was not on the Council myself to have advocated your high claims and taken a share in promoting your success. It is now long since I have heard from you, but this terrible disruption between the North and South has, I suppose, rendered the pursuit of science rather difficult, and the necessary funds also difficult of attainment. I should like very much to hear how you are getting on, and whether there is any like-

lihood of your being able to come over in the course of the summer or autumn. I fully expected you last year, and was very much disappointed that you could not realize your intention. I have this day sent to you through Baillière, the last decade of the Jermyn St. publications.[1] You will see that Huxley has taken up the subject of the Devonian fishes in a truly scientific spirit. . . .

FROM OWEN TO AGASSIZ.

BRITISH MUSEUM, *Aug.* 30, 1862.

MY DEAR AGASSIZ, — I have received, and since its reception have devoted most of my spare moments to the study of, your fourth volume of the "Natural History of the United States," — a noble contribution to our science, and worthy of your great name.

The demonstration of the unity of plan pervading the diversities of the Polype, Hydroids, Acalephal and Echinodermal modifications of your truly natural group of Radiates, is to my mind perfect, and I trust that the harsh and ugly and essentially error-breeding name of Coelenterata may have received its final sentence of exile from lasting and rational zoölogical terminology.

[1] Publications of the Geological Survey of England.

I shall avail myself of opportunities for bringing myself to your recollection by such brochures as I have time for. One of them will open to your view something of the nature of the contest here waging to obtain for England a suitable Museum of Natural History, equivalent to her wealth and colonies and maritime business. In this I find you a valuable ally, and have cited from the Reports of your Museum of Comparative Zoölogy in support of my own claims for space.

I was glad to hear from Mr. Bates that the Megatherium had not gone to the bottom, but had been rescued, and that it was probably ere this in your Museum at Cambridge. I trust it may be so.

A line from you or the sight of any friend of yours is always cheering to me. Our friends Enniskillen and Egerton are both well. . . .

I remain ever truly yours,

RICHARD OWEN.

As has been seen by a previous letter from Sir Roderick Murchison, Agassiz tried from time to time to give his English friends more just views of our national struggle. The letter to which the following is an answer is

missing, but one may easily infer its tenor, and the pleasure it had given him.

TO SIR PHILIP DE GREY EGERTON.

NAHANT, MASS., *August* 15, 1862.

. . . I feel so thankful for your words of sympathy, that I lose not an hour in expressing my feeling. It has been agonizing week after week to receive the English papers, and to see there the noble devotion of the men of the North to their country and its government, branded as the service of mercenaries. You know I am not much inclined to meddle with politics; but I can tell you that I have never seen a more generous and prompt response to the call of country than was exhibited last year, and is exhibiting now, in the loyal United States. In the last six weeks nearly 300,000 men have volunteered, and I am satisfied that the additional 300,000 will be forthcoming without a draft in the course of the next month. And believe me, it is not for the sake of the bounty they come forward, for our best young men are the first to enlist; if anything can be objected to these large numbers of soldiers, it is that it takes away the best material that the land possesses. I thank you once more for your warm sympathy.

I needed it the more, as it is almost the first friendly word of that kind I have received from England, and I began to question the humanity of your civilization. . . . Under present circumstances, you can well imagine that I cannot think of leaving Cambridge, even for a few weeks, much as I wish to take some rest, and especially to meet your kind invitation. But I feel that I have a debt to pay to my adopted country, and all I can now do is to contribute my share toward maintaining the scientific activity which has been awakened during the last few years, and which even at this moment is on the increase.

I am now at Nahant, on the sea-shore, studying embryology chiefly with reference to paleontology, and the results are most satisfactory. I have had an opportunity already of tracing the development of the representatives of three different families, upon the embryology of which we had not a single observation thus far, and of making myself familiar with the growth of many others. With these accessions I propose next winter seriously to return to my first scientific love. . . .

I have taken with me to the sea-shore your and Huxley's "Contributions to the Devonian

Fishes," and also your notice of Carboniferous fish-fauna; but I have not yet had a chance to study them critically, from want of time, having been too successful with the living specimens to have a moment for the fossils. The season for sea-shore studies is, however, drawing rapidly to an end, and then I shall have more leisure for my old favorites.

I am very sorry to hear such accounts of the sufferings of the manufacturing districts in England. I wish I could foretell the end of our conflict; but I do not believe it can now be ended before slavery is abolished, though I thought differently six months ago. The most conservative men at the North have gradually come to this conviction, and nobody would listen for a moment to a compromise with the southern slave power. Whether we shall get rid of it by war measures or by an emancipation proclamation, I suppose the President himself does not yet know. I do not think that we shall want more money than the people are willing to give. Private contributions for the comfort of the army are really unbounded. I know a gentleman, not among the richest in Boston, who has already contributed over $30,000; and I heard yesterday of a shop-boy who tendered all his earnings of

many years to the relief committee, — $2,000, retaining *nothing* for himself, — and so it goes all round. Of course we have croakers and despondent people, but they no longer dare to raise their voices; from which I infer that there is no stopping the storm until by the natural course of events the atmosphere is clear and pure again.

Ever truly your friend,

LOUIS AGASSIZ.

Agassiz had now his time more at his own disposal since he had given up his school and had completed also the fourth volume of his "Contributions." Leisure time he could never be said to have, but he was free to give all his spare time and strength to the Museum, and to this undivided aim, directly or indirectly, the remainder of his life was devoted. Although at intervals he received generous aid from the Legislature or from private individuals for the further development of the Museum, its growth outran such provision, and especially during the years of the war the problem of meeting expenses was often difficult of solution. To provide for such a contingency Agassiz made in the winter of 1863 the most extensive lecturing tour he

had ever undertaken, even in his busiest lecturing days. He visited all the large cities and some of the smaller towns from Buffalo to St. Louis. While very remunerative, and in many respects delightful, since he was received with the greatest cordiality, and lectured everywhere to enthusiastic crowds, this enterprise was, nevertheless, of doubtful economy even for his scientific aims. Agassiz was but fifty-six, yet his fine constitution began to show a fatigue hardly justified by his years, and the state of his health was already a source of serious anxiety to his friends. He returned much exhausted, and passed the summer at Nahant, where the climate always benefited him, while his laboratory afforded the best conditions for work. If this summer home had a fault, it was its want of remoteness. He was almost as much beset there, by the interruptions to which a man in his position is liable, as in Cambridge.

His letters show how constantly during this nominal vacation his Museum and its interests occupied his thoughts. One is to his brother-in-law, Thomas G. Cary, whose residence was in San Francisco, and who had been for years his most efficient aid in obtaining collections from the Pacific Coast.

TO MR. THOMAS G. CARY.

CAMBRIDGE, *March* 23, 1863.

DEAR TOM, — For many years past your aid in fostering the plans of the Museum in Cambridge has greatly facilitated the progress of that establishment in everything relating to the Natural History of California, and now that it has become desirable to extend our scheme to objects which have thus far been neglected I make another appeal to you.

Every day the history of mankind is brought into more and more intimate connection with the natural history of the animal creation, and it is now indispensable that we should organize an extensive collection to illustrate the natural history of the uncivilized races. Your personal acquaintance with business friends in almost every part of the globe has suggested to me the propriety of addressing to you a circular letter, setting forth the objects wanted, and requesting of you the favor to communicate it as widely as possible among your friends.

To make the most instructive collections relative to the natural history of mankind, two classes of specimens should be brought together, one concerning the habits and pursuits

of the races, the other concerning the physical constitution of the races themselves.

With reference to the first it would be desirable to collect articles of clothing and ornaments of all the races of men, their implements, tools, weapons, and such models or drawings of their dwellings as may give an idea of their construction; small canoes and oars as models of their vessels, or indications of their progress in navigation; in one word, everything that relates to their avocations, their pursuits, their habits, their mode of worship, and whatever may indicate the dawn or progress of the arts among them. As to articles of clothing, it would be preferable to select such specimens as have actually been worn or even cast off, rather than new things which may be more or less fanciful and not indicate the real natural condition and habits of a race.

With regard to the collections intended to illustrate the physical constitution of the races it is more difficult to obtain instructive specimens, as the savage races are generally inclined to hold sacred all that relates to their dead; yet whenever an opportunity is afforded to obtain skulls of the natives of different parts of the world, it should be industriously improved, and good care taken to mark the

skulls in such a way that their origin cannot be mistaken. Beside this, every possible effort should be made to obtain perfect heads, preserved in alcohol, so that all their features may be studied minutely and compared. Where this cannot be done portraits or photographs may be substituted.

Trusting that you may help me in this way to bring together in Cambridge a more complete collection, illustrative of the natural history of mankind than exists thus far anywhere,[1]

I remain, ever truly your friend and brother,

LOUIS AGASSIZ.

The following letter to Mr. Ticknor is in the same spirit as previous ones to Mr. Haldeman and others, concerning the distribution of fishes in America. It is given at the risk of some repetition, because it illustrates Agassiz's favorite idea that a key to the original combination of faunæ in any given system of fresh waters, might be reached through a closer study than has yet been possible of the geographical or local circumscription of their inhabitants.

[1] All the ethnographical collections of the Museum of Comparative Zoölogy have now been transferred to the Peabody Museum, where they more properly belong.

TO MR. GEORGE TICKNOR.

NAHANT, *October* 24, 1863.

MY DEAR SIR, — Among the schemes which I have devised for the improvement of the Museum, there is one for the realization of which I appeal to your aid and sympathy. Thus far the natural productions of the rivers and lakes of the world have not been compared with one another, except what I have done in comparing the fishes of the Danube with those of the Rhine and of the Rhone, and those of the great Canadian lakes with those of the Swiss lakes.

I now propose to resume this subject on the most extensive scale, since I see that it has the most direct bearing upon the transmutation theory. . . . First let me submit to you my plan.

Rivers and lakes are isolated by the land and sea from one another. The question is, then, how they came to be peopled with inhabitants differing both from those on land and those in the sea, and how does it come that every hydrographic basin has its own inhabitants more or less different from those of any other basin? Take the Ganges, the Nile, and the Amazons. There is not a living being

in the one alike to any one in the others, etc. Now to advance the investigation to the point where it may tell with reference to the scientific doctrines at present under discussion, it is essential to know the facts in detail, with reference to every fresh-water basin on earth. I have already taken means to obtain the tenants of all the rivers of Brazil, and partly of Russia, and I hope you may be able to put me in the way of getting those of Spain, if not of some other country beside. The plan I propose for that country would be worthy of the Doctors of Salamanca in her brightest days. If this alone were carried out, it would be, I believe, sufficient to settle the whole question.

My idea is to obtain separate collections from all the principal rivers of Spain and Portugal, and even to have several separate collections from the larger rivers, one from their lower course, one from their middle course, and another from their head-waters. Take, for instance, the Douro. One collection ought to be made at Oporto, and several higher up, among its various tributaries and in its upper course; say, one at Zamora and Valladolid, one at Salamanca from the Tormes River, one at Leon from the Esla River, one

at Burgos and Palencia from the northern tributaries, one at Soria and Segovia from the southern tributaries. If this could be done on such a scale as I propose, it would in itself be a work worthy of the Spanish government, and most creditable to any man who should undertake it. The fact is that nothing of the kind has ever been done yet anywhere. A single collection from the Minho would be sufficient, say from Orense or Melgaço. From the northern rivers along the gulf of Biscay all that would be necessary would be one thoroughly complete collection from one of the little rivers that come down from the mountains of Asturias, say from Oviedo.

The Ebro would require a more elaborate survey. From its upper course, one collection would be needed from Haro or Frias or Miranda; another from Saragossa, and one from its mouth, including the minnows common among the brackish waters near the mouth of large rivers. In addition to this, one or two of the tributaries of the Ebro, coming down from the Pyrenees, should be explored in the same manner; say one collection from Pampeluna, and one from Urgel, or any other place on the southern slope of the Pyrenees. A collection made at Barcelona from the river

and the brackish marshes would be equally desirable; another from the river at Valencia, and, if possible, also from its head-waters at Ternel; another from the river Segura at Murcia, and somewhere in the mountains from its head-waters. Granada would afford particular interest as showing what its mountain streams feed. A collection from the Almeria River at Almeria, or from any of the small rivers of the southern coast of Spain, would do; and it would be the more interesting if another from the river Xenil could be obtained at or near Granada, to compare with the inhabitants of the waters upon the southern slope of the Sierra Nevada.

Next would come the Guadalquivir, from which a collection should be made at San Lucar, with the brackish water species; another at Seville or Cordova, one among the head-waters from the Sierra Nevada, and another from the mountains of the Mancha. From the Guadiana a collection from Villa Real, with the brackish species; one from Badajoz, and one from the easternmost headwaters, and about where the river is lost under ground.

The Tagus would again require an extensive exploration. In the first place a thorough

collection of all the species found in the great estuary ought to be made with the view of ascertaining how far marine Atlantic species penetrate into the river basin; then one from Santarem, and another either from Talavera or Toledo or Aranjuez, and one from the head-waters in Guadalaxara, and another in Molina.

The collections made at different stations ought carefully to be kept in distinct jars or kegs, with labels so secure that no confusion or mistake can arise. But the specimens collected at the same station may be put together in the same jar. These collections require, in fact, very little care. (Here some details about mode of putting up specimens, transportation, etc.) If the same person should collect upon different stations, either in the same or in different hydrographic basins, the similarity of the specimens should not be a reason for neglecting to preserve them. What is aimed at is not to secure a variety of species, but to learn in what localities the same species may occur again and again, and what are the localities which nourish different species, no matter whether these species are in themselves interesting or not, new to science or known for ages, whether valuable for the

table or unfit to eat. The mere fact of their distribution is the point to be ascertained, and this, as you see, requires the most extensive collections, affording in themselves comparatively little interest, but likely to lead, by a proper discussion of the facts, to the most unexpected philosophical results. . . . Do, please, what you can in this matter. Spain alone might give us the materials to solve the question of transmutation *versus* creation. I am going to make a similar appeal to my friends in Russia for materials from that country, including Siberia and Kamschatka. Our own rivers are not easily accessible now.

Ever truly your friend,

L. AGASSIZ.

CHAPTER XX.

1863–1864 : ÆT. 56–57.

Correspondence with Dr. S. G. Howe. — Bearing of the War on the Position of the Negro Race. — Affection for Harvard College. — Interest in her General Progress. — Correspondence with Emerson concerning Harvard. — Glacial Phenomena in Maine.

AGASSIZ's letters give little idea of the deep interest he felt in the war between North and South, and its probable issue with reference to the general policy of the nation, and especially to the relation between the black and white races. Although any judgment upon the accuracy of its conclusions would now be premature, the following correspondence between Agassiz and Dr. S. G. Howe is nevertheless worth considering, as showing how the problem presented itself to the philanthropist and the naturalist from their different stand-points.

FROM DR. S. G. HOWE.

PORTSMOUTH, *August* 3, 1863.

MY DEAR AGASSIZ, — You will learn by a glance at the inclosed circular the object of the commission of which I am a member.

The more I consider the subject to be examined and reported upon, the more I am impressed by its vastness; the more I see that its proper treatment requires a consideration of political, physiological, and ethnological principles. Before deciding upon any political policy, it is necessary to decide several important questions, which require more knowledge for their solution than I possess.

Among these questions, this one occupies me most now. Is it probable that the African race, represented by less than two million blacks and a little more than two million mulattoes, unrecruited by immigration, will be a persistent race in this country? or will it be absorbed, diluted, and finally effaced by the white race, numbering twenty-four millions, and continually increased by immigration, beside natural causes.

Will not the general practical amalgamation fostered by slavery become more general after its abolition? If so, will not the proportion of mulattoes become greater and that of the pure blacks less? With an increase and final numerical prevalence of mulattoes the question of the fertility of the latter becomes a very important element in the calculation. Can it be a persistent race here where

pure blacks are represented by 2, and the whites by 20–24?

Is it not true that in the Northern States at least the mulatto is unfertile, leaving but few children, and those mainly lymphatic and scrofulous?

In those sections where the blacks and mulattoes together make from seventy to eighty and even ninety per cent. of the whole population will there be, after the abolition of slavery, a sufficiently large influx of whites to counteract the present numerical preponderance of blacks?

It looks now as if the whites would *exploiter* the labors of the blacks, and that social servitude will continue long in spite of political equality.

You will see the importance of considering carefully the natural laws of increase and their modification by existing causes before deciding upon any line of policy.

If there be irresistible natural tendencies to the growth of a persistent black race in the Gulf and river States, we must not make bad worse by futile attempts to resist it. If, on the other hand, the natural tendencies are to the diffusion and final disappearance of the black (and colored) race, then our policy should be modified accordingly.

I should be very glad, my dear sir, if you could give me your views upon this and cognate matters. If, however, your occupations will not permit you to give time to this matter, perhaps you will assist me by pointing to works calculated to throw light upon the subject of my inquiry, or by putting me in correspondence with persons who have the ability and the leisure to write about it.

I remain, dear sir, faithfully,

SAMUEL G. HOWE.

TO DR. S. G. HOWE.

NAHANT, *August* 9, 1863.

MY DEAR DOCTOR, — When I acknowledged a few days ago the receipt of your invitation to put in writing my views upon the management of the negro race as part of the free population of the United States, I stated to you that there was a preliminary question of the utmost importance to be examined first, since whatever convictions may be formed upon that point must necessarily influence everything else relating to the subject. The question is simply this: Is there to be a permanent black population upon the continent after slavery is everywhere abolished and no inducement remains to foster its increase?

Should this question be answered in the negative, it is evident that a wise policy would look to the best mode of removing that race from these States, by the encouragement and acceleration of emigration. Should the question be answered, on the contrary, in the affirmative, then it is plain that we have before us one of the most difficult problems, upon the solution of which the welfare of our own race may in a measure depend, namely, the combination in one social organization of two races more widely different from one another than all the other races. In effecting this combination it becomes our duty to avoid the recurrence of great evils, one of which is already foreshadowed in the advantage which unscrupulous managers are taking of the freedmen, whenever the latter are brought into contact with new social relations.

I will, for the present, consider only the case of the unmixed negroes of the Southern States, the number of which I suppose to be about two millions. It is certainly not less, — it may be a little more. From whatever point of view you look upon these people you must come to the conclusion that, left to themselves, they will perpetuate their race *ad infinitum* where they are. According to the prevalent

theory of the unity of mankind it is assumed that the different races have become what they are in consequence of their settlement in different parts of the world, and that the whole globe is everywhere a fit abode for human beings who adapt themselves to the conditions under which they live. According to the theory of a multiple origin of mankind the different races have first appeared in various parts of the globe, each with the peculiarities best suited to their primitive home. Aside from these theoretical views the fact is, that some races inhabit very extensive tracts of the earth's surface, and are now found upon separate continents, while others are very limited in their range. This distribution is such that there is no reason for supposing that the negro is less fitted permanently to occupy at least the warmer parts of North and South America, than is the white race to retain possession of their more temperate portions. Assuming our pure black race to be only two millions, it is yet larger than the whole number of several races that have held uninterrupted possession of different parts of the globe ever since they have been known to the white race. Thus the Hottentots and the Abyssinians have maintained themselves in

their respective homes without change ever since their existence has been known to us, even though their number is less than that of our pure black population. The same, also, is the case with the population of Australia and of the Pacific islands. The Papuan race, the Negrillo race, the Australian race proper, distinct from one another, as well as from all other inhabitants of the earth, number each fewer inhabitants than already exist of the negro race in the United States alone, not to speak of Central and South America.

This being the case there is, it seems to me, no more reason to expect a disappearance of the negro race from the continent of America without violent interference, than to expect a disappearance of the races inhabiting respectively the South Sea Islands, Australia, the Cape of Good Hope, or any other part of the globe tenanted by the less populous races. The case of the American Indians, who gradually disappear before the white race, should not mislead us, as it is readily accounted for by the peculiar character of that race. The negro exhibits by nature a pliability, a readiness to accommodate himself to circumstances, a proneness to imitate those among whom he lives, — characteristics which are entirely for-

eign to the Indian, while they facilitate in every way the increase of the negro. I infer, therefore, from all these circumstances that the negro race must be considered as permanently settled upon this continent, no less firmly than the white race, and that it is our duty to look upon them as co-tenants in the possession of this part of the world.

Remember that I have thus far presented the case only with reference to the Southern States, where the climate is particularly favorable to the maintenance and multiplication of the negro race. Before drawing any inference, however, from my first assertion that the negro will easily and without foreign assistance maintain himself and multiply in the warmer parts of this continent, let us consider a few other features of this momentous question of race. Whites and blacks may multiply together, but their offspring is never either white or black; it is always mulatto. It is a half-breed, and shares all the peculiarities of half-breeds, among whose most important characteristics is their sterility, or at least their reduced fecundity. This shows the connection to be contrary to the normal state of the races, as it is contrary to the preservation of species in the animal kingdom. . . . Fai

from presenting to me a natural solution of our difficulties, the idea of amalgamation is most repugnant to my feelings. It is now the foundation of some of the most ill-advised schemes. But wherever it is practiced, amalgamation among different races produces shades of population, the social position of which can never be regular and settled. From a physiological point of view, it is sound policy to put every possible obstacle to the crossing of the races, and the increase of half-breeds. It is unnatural, as shown by their very constitution, their sickly physique, and their impaired fecundity. It is immoral and destructive of social equality as it creates unnatural relations and multiplies the differences among members of the same community in a wrong direction.

From all this it is plain that the policy to be adopted toward the miscellaneous colored population with reference to a more or less distant future should be totally different from that which applies to the pure black; for while I believe that a wise social economy will foster the progress of every pure race, according to its natural dispositions and abilities, and aim at securing for it a proper field for the fullest development of all its capabili-

ties, I am convinced also that no efforts should be spared to check that which is inconsistent with the progress of a higher civilization and a purer morality. I hope and trust that as soon as the condition of the negro in the warmer parts of our States has been regulated according to the laws of freedom, the colored population in the more northern parts of the country will diminish. By a natural consequence of unconquerable affinities, the colored people in whom the negro nature prevails will tend toward the South, while the weaker and lighter ones will remain and die out among us.

Entertaining these views upon the fundamental questions concerning the races, the next point for consideration is the policy to be adopted under present circumstances, in order to increase the amount of good which is within our grasp and lessen the evil which we may avert. This will be for another letter.

Very truly yours,

LOUIS AGASSIZ.

FROM THE SAME TO THE SAME.

August 10, 1863.

MY DEAR DOCTOR, — I am so deeply impressed with the dangers awaiting the prog-

ress of civilization, should the ideas now generally prevalent about amalgamation gain sufficient ascendency to exert a practical influence upon the management of the affairs of the nation, that I beg leave to urge a few more considerations upon that point.

In the first place let me insist upon the fact that the population arising from the amalgamation of two races is always degenerate, that it loses the excellences of both primitive stocks to retain the vices or defects of both, and never to enjoy the physical vigor of either. In order clearly to appreciate the tendencies of amalgamation, it is indispensable to discriminate correctly between the differences distinguishing one race from another and those existing between different nationalities of the same race. For while the mixture of nationalities of the same race has always proved beneficial as far as we are taught by history, the mixture of races has produced a very different result. We need only look at the inhabitants of Central America, where the white, the negro, and the Indian races are more or less blended, to see the baneful effects of such an amalgamation. The condition of the Indians on the borders of civilization in the United States and in Can-

ada, in their contact with the Anglo-Saxons as well as with the French, testifies equally to the pernicious influence of amalgamation of races. The experience of the Old World points in the same direction at the Cape of Good Hope, in Australia; everywhere, in fact, history speaks as loudly in favor of the mixture of clearly related nations as she does in condemnation of the amalgamation of remote races. We need only think of the origin of the English nation, of that of the United States, etc. The question of breeding in-and-in, that of marriage among close relations, is again quite distinct. In fact, there is hardly a more complicated subject in physiology, or one requiring nicer discriminations, than that of the multiplication of man, and yet it is constantly acted upon as if it needed no special knowledge. I beseech you, therefore, while you are in a position to exert a leading influence in the councils of the nation upon this most important subject to allow no preconceived view, no favorite schemes, no immediate object, to bias your judgment and mislead you. I do not pretend to be in possession of absolute truth. I only urge upon you the consideration of unquestionable facts before you form a final opinion and decide

upon a fixed policy. Conceive for a moment the difference it would make in future ages for the prospects of republican institutions, and our civilization generally, if instead of the manly population descended from cognate nations the United States should be inhabited by the effeminate progeny of mixed races, half Indian, half negro, sprinkled with white blood. Can you devise a scheme to rescue the Spaniards of Mexico from their degradation? Beware, then, of any policy which may bring our own race to their level.

These considerations lead me naturally to the inquiry into the peculiarities of the two races, in order to find out what may be most beneficial for each. I rejoice in the prospect of universal emancipation, not only from a philanthropic point of view, but also because hereafter the physiologist and ethnographer may discuss the question of the races and advocate a discriminating policy regarding them, without seeming to support legal inequality. There is no more one-sided doctrine concerning human nature than the idea that all men are equal, in the sense of being equally capable of fostering human progress and advancing civilization, especially in the various spheres of intellectual and moral activity. If this be

so, then it is one of our primary obligations to remove every obstacle that may retard the highest development, while it is equally our duty to promote the humblest aspirations that may contribute to raise the lowest individual to a better condition in life.

The question is, then, what kind of common treatment is likely to be the best for all men, and what do the different races, taken singly, require for themselves? That legal equality should be the common boon of humanity can hardly be matter for doubt nowadays, but it does not follow that social equality is a necessary complement of legal equality. I say purposely legal equality, and not political equality, because political equality involves an equal right to every public station in life, and I trust we shall be wise enough not to complicate at once our whole system with new conflicting interests, before we have ascertained what may be the practical working of universal freedom and legal equality for two races, so different as the whites and negroes, living under one government. We ought to remember that what we know of the negro, from the experience we have had of the colored population of the North, affords but a very inadequate standard by which to judge

of the capabilities of the pure blacks as they exist in the South. We ought, further, to remember that the black population is likely at all times to outnumber the white in the Southern States. We should therefore beware how we give to the blacks rights, by virtue of which they may endanger the progress of the whites before their temper has been tested by a prolonged experience. Social equality I deem at all times impracticable, — a natural impossibility, from the very character of the negro race. Let us consider for a moment the natural endowments of the negro race as they are manifested in history on their native continent, as far as we can trace them back, and compare the result with what we know of our own destinies, in order to ascertain, within the limits of probability, whether social equality with the negro is really an impossibility.

We know of the existence of the negro race, with all its physical peculiarities, from the Egyptian monuments, several thousand years before the Christian era. Upon these monuments the negroes are so represented as to show that in natural propensities and mental abilities they were pretty much what we find them at the present day, — indolent,

playful, sensual, imitative, subservient, good-natured, versatile, unsteady in their purpose, devoted and affectionate. From this picture I exclude the character of the half-breeds, who have, more or less, the character of their white parents. Originally found in Africa, the negroes seem at all times to have presented the same characteristics wherever they have been brought into contact with the white race; as in Upper Egypt, along the borders of the Carthaginian and Roman settlements in Africa, in Senegal in juxtaposition with the French, in Congo in juxtaposition with the Portuguese, about the Cape and on the eastern coast of Africa in juxtaposition with the Dutch and the English. While Egypt and Carthage grew into powerful empires and attained a high degree of civilization; while in Babylon, Syria, and Greece were developed the highest culture of antiquity, the negro race groped in barbarism and *never originated a regular organization among themselves.* This is important to keep in mind, and to urge upon the attention of those who ascribe the condition of the modern negro wholly to the influence of slavery. I do not mean to say that slavery is a necessary condition for the organization of the negro

race. Far from it. They are entitled to their freedom, to the regulation of their own destiny, to the enjoyment of their life, of their earnings, of their family circle. But with all this nowhere do they appear to have been capable of rising, by themselves, to the level of the civilized communities of the whites, and therefore I hold that they are incapable of living on a footing of social equality with the whites in one and the same community without becoming an element of social disorder.[1]

I am not prepared to state what political privileges they are fit to enjoy now; though I have no hesitation in saying that they should be equal to other men before the law. The right of owning property, of bearing witness, of entering into contracts, of buying and selling, of choosing their own domicile, would give them ample opportunity of showing in a comparatively short time what political rights might properly and safely be granted to them in successive installments. No man has a right

[1] I fear the expression "social equality" may be misunderstood in this connection. It means here only the relations which would arise from the mixture of the two races, and thus affect the organization of society as a whole. It does not refer to any superficial or local social rules, such as sharing on common ground public conveyances, public accommodations, and the like. — ED.

to what he is unfit to use. Our own best rights have been acquired successively. I cannot, therefore, think it just or safe to grant at once to the negro all the privileges which we ourselves have acquired by long struggles. History teaches us what terrible reactions have followed too extensive and too rapid changes. Let us beware of granting too much to the negro race in the beginning, lest it become necessary hereafter to deprive them of some of the privileges which they may use to their own and our detriment. All this I urge with reference to the pure blacks of the South. As to the half-breeds, especially in the Northern States, I have already stated it to be my opinion that their very existence is likely to be only transient, and that all legislation with reference to them should be regulated with this view, and so ordained as to accelerate their disappearance from the Northern States.

Let me now sum up my answer to some of your direct questions.

1st. Is it probable that the African race will be a persistent race in this country, or will it be absorbed, diluted, and finally effaced by the white race?

I believe it will continue in the Southern States, and I hope it may gradually die out at

the North, where it has only an artificial foothold, being chiefly represented by half-breeds, who do not constitute a race by themselves.

2d. Will not the practical amalgamation fostered by slavery become more general after its abolition?

Being the result of the vices engendered by slavery, it is to be hoped that the emancipation of the blacks, by securing to them a legal recognition of their natural ties, will tend to diminish this unnatural amalgamation and lessen everywhere the number of these unfortunate half-breeds. My reason for believing that the colored population of the North will gradually vanish is founded in great degree upon the fact that that population does not increase where it exists now, but is constantly recruited by an influx from the South. The southern half-breeds feel their false position at the South more keenly than the blacks, and are more inclined to escape to the North than the individuals of purer black blood. Remove the oppression under which the colored population now suffers, and the current will at once be reversed; blacks and mulattoes of the North will seek the sunny South. But I see no cause which should check the increase of the black population in the South-

ern States. The climate is genial to them; the soil rewards the slightest labor with a rich harvest. The country cannot well be cultivated without real or fancied danger to the white man, who, therefore, will not probably compete with the black in the labors of the field, thus leaving to him an opportunity for easy and desirable support.

3d. In those sections where the blacks and mulattoes together make from seventy to eighty and even ninety per cent. of the population will there be, after the abolition of slavery, a sufficiently large influx of whites to counteract the present numerical preponderance of blacks?

To answer this question correctly we must take into consideration the mode of distribution of the white and of the colored population in the more Southern States. The whites inhabit invariably the sea-shores and the more elevated grounds, while the blacks are scattered over the lowlands. This peculiar localization is rendered necessary by the physical constitution of the country. The lowlands are not habitable in summer by the whites between sunset and sunrise. All the wealthy whites, and in the less healthy regions even the overseers, repair in the evening to the sea-

shore or to the woodlands, and return only in the morning to the plantation, except during the winter months, after the first hard frost, when the country is everywhere habitable by all. This necessarily limits the area which can be tenanted by the whites, and in some States that area is very small as compared with that habitable by the blacks. It is therefore clear that with a free black population, enjoying identical rights with the whites, these States will sooner or later become negro States, with a comparatively small white population. This is inevitable; we might as soon expect to change the laws of nature as to avert this result. I believe it may in a certain sense work well in the end. But any policy based upon different expectations is doomed to disappointment.

4th. How to prevent the whites from securing the lion's share of the labor of the blacks?

This is a question which my want of familiarity with the operations of the laboring classes prevents me from answering in a manner satisfactory to myself. Is it not possible to apply to the superintendence of the working negroes something like the system which regulates the duties of the foreman in all our manufacturing establishments?

I should like to go on and attempt to devise some scheme in conformity with the convictions I have expressed in these letters. But I have little ability in the way of organizing, and then the subject is so novel that I am not prepared to propose anything very definite.

Ever truly yours,

LOUIS AGASSIZ.

FROM DR. S. G. HOWE.

NEW YORK, *August* 18, 1863.

MY DEAR AGASSIZ, — I cannot refrain from expressing my thanks for your prompt compliance with my request, and for your two valuable letters.

Be assured I shall try to keep my mind open to conviction and to forbear forming any theory before observing a wide circle of facts. I do not know how you got the idea that I had decided in favor of anything about the future of the colored population. I have corresponded with the founders of "La Société Cosmopolite pour la fusion des races humaines" in France, — an amalgamation society, founded upon the theory that the perfect man is to be the result of the fusion of all the races upon earth. I have not, however, the honor of being a member thereof. In-

deed, I think it hardly exists. I hear, too, that several of our prominent anti-slavery gentlemen, worthy of respect for their zeal and ability, have publicly advocated the doctrines of amalgamation; but I do not know upon what grounds.

I do, indeed, hold that in this, as in other matters, we are to do the manifest right, regardless of consequences. If you ask me who is to decide what is the manifest right, I answer, that in morals, as well as in mathematics, there are certain truths so simple as to be admitted at sight as axioms by every one of common intelligence and honesty. The right to life is as clear as that two and two make four, and none dispute it. The right to liberty and to ownership of property fairly earned is just as clear to the enlightened mind as that $5 \times 6 = 30$; but the less enlightened may require to reflect about it, just as they may want concrete signs to show that five times six do really make thirty. As we ascend in numbers and in morals, the intuitive perceptions become less and less; and though the truths are there, and ought to be admitted as axiomatic, they are not at once seen and felt by ordinary minds.

Now so far as the rights of blacks and the

duties of whites are manifest to common and honest minds, so far would I admit the first and perform the second, though the heavens fall. I would not only advocate entire freedom, equal rights and privileges, and open competition for social distinction, but what now seems to me the shocking and downward policy of amalgamation. But the heavens are not going to fall, and we are not going to be called upon to favor any policy discordant with natural instincts and cultivated tastes.

A case may be supposed in which the higher race ought to submit to the sad fate of dilution and debasement of its blood, — as on an island, and where long continued wrong and suffering had to be atoned for. But this is hardly conceivable, because, even in what seems punishment and atonement, the law of harmonious development still rules. God does not punish wrong and violence done to one part of our nature, by requiring us to do wrong and violence to another part. Even Nemesis wields rather a guiding-rod than a scourge. We need take no step backward, but only aside, to get sooner into the right path.

Slavery has acted as a disturbing force in the development of our national character and

produced monstrous deformities of a bodily as well as moral nature, for it has impaired the purity and lowered the quality of the national blood. It imported Africans, and, to prevent their extinction by competition with a more vigorous race, it set a high premium on colored blood. It has fostered and multiplied a vigorous black race, and engendered a feeble mulatto breed. Many of each of these classes have drifted northward, right in the teeth of thermal laws, to find homes where they would never live by natural election. Now, by utterly rooting out slavery, and by that means alone, shall we remove these disturbing forces and allow fair play to natural laws, by the operation of which, it seems to me, the colored population will disappear from the Northern and Middle States, if not from the continent, before the more vigorous and prolific white race. It will be the duty of the statesman to favor, by wise measures, the operation of these laws and the purification and elevation of the national blood.

In the way of this is the existence of the colored population of the Northern and Middle States. Now, while we should grant to every human being all the rights we claim for ourselves, and bear in mind the cases of indi-

vidual excellence of colored people, we must, I think, admit that mulattoism is hybridism, and that it is unnatural and undesirable. It has been brought to its present formidable proportions by several causes, — mainly by slavery. Its evils are to be met and lessened as far as may be, by wise statesmanship and by enlightenment of public opinion. These may do much.

Some proclaim amalgamation as the remedy, upon the theory that by diluting black blood with white blood in larger and larger proportions, it will finally be so far diluted as to be imperceptible and will disappear. They forget that we may not do the wrong that right may come of it. They forget that no amount of diffusion will exterminate whatever exists; that a pint of ink diffused in a lake is still there, and the water is only the less pure.

Others persist that mulattoism is not and cannot be persistent beyond four generations. In other words, that like some other abnormal and diseased conditions it is self-limiting, and that the body social will be purged of it.

In the face of these and other theories, it is our duty to gather as many facts and as much knowledge as is possible, in order to throw

light upon every part of the subject; nobody can furnish more than you can.

Faithfully yours,

SAMUEL G. HOWE.[1]

The Museum and his own more immediate scientific work must naturally take precedence in any biography of Agassiz, and perhaps, for this reason, too little prominence has been given in these pages to his interest in general education, and especially in the general welfare and progress of Harvard College. He was deeply attached to the University with which he had identified himself in America. While he strained every nerve to develop his own scientific department, which had no existence at Harvard until his advent there, no one of her professors was more concerned than himself for the organization of the college as a whole. A lover of letters as well as a devotee of nature, he valued every provision for a well proportioned intellectual training. He welcomed the creation of an Academic Council for the promotion of free and

[1] In this correspondence with Dr. Howe, one or two phrases in Agassiz's letters are interpolated from a third unfinished letter, which was never forwarded to Dr. Howe. These sentences connect themselves so directly with the sense of the previous letters that it seemed worth while to add them. — ED.

frequent interchange of opinion between the different heads of departments, and, when in Cambridge, he was never absent from the meetings. He urged, also, the introduction of university lectures, to the establishment of which he largely contributed, and which he would fain have opened to all the students. He advocated the extension of the elective system, believing that while it might perhaps give a pretext for easy evasion of duty to the more inefficient and lazy students, it gave larger opportunities to the better class, and that the University should adapt itself to the latter rather than the former. "The bright students," he writes to a friend, "are now deprived of the best advantages to be had here, because the dull or the indifferent must still be treated as children."

The two following letters, from their bearing on general university questions, are not out of place here. Though occasioned by a slight misconception, they are so characteristic of the writers, and of their relation to each other, that it would be a pity to omit them.

TO RALPH WALDO EMERSON.

December 12, 1864.

My dear Emerson, — If your lecture on universities, the first of your course, has been correctly reported to me, I am almost inclined to quarrel with you for having missed an excellent chance to help me, and advance the true interests of the college. You say that Natural History is getting too great an ascendency among us, that it is out of proportion to other departments, and hint that a check-rein would not be amiss on the enthusiastic professor who is responsible for this.

Do you not see that the way to bring about a well-proportioned development of all the resources of the University is not to check the natural history department, but to stimulate all the others? not that the zoölogical school grows too fast, but that the others do not grow fast enough? This sounds invidious and perhaps somewhat boastful; but it is you and not I who have instituted the comparison. It strikes me you have not hit upon the best remedy for this want of balance. If symmetry is to be obtained by cutting down the most vigorous growth, it seems to me it would be better to have a little irregularity here and

there. In stimulating, by every means in my power, the growth of the Museum and the means of education connected with it, I am far from having a selfish wish to see my own department tower above the others. I wish that every one of my colleagues would make it hard for me to keep up with him, and there are some among them, I am happy to say, who are ready to run a race with me. Perhaps, after all, I am taking up the cudgels against you rather prematurely. If I had not been called to New Haven, Sunday before last, by Professor Silliman's funeral, I should have been present at your lecture myself. Having missed it, I may have heard this passage inaccurately repeated. If so, you must forgive me, and believe me always, whatever you did or did not say,

Ever truly your friend,

LOUIS AGASSIZ.

FROM RALPH WALDO EMERSON.

CONCORD, *December* 13, 1864.

DEAR AGASSIZ, — I pray you have no fear that I did, or can, say any word unfriendly to you or to the Museum, for both of which blessings — the cause and the effect — I daily thank Heaven! May you both increase and multiply for ages!

I cannot defend my lectures, — they are prone to be clumsy and hurried botches, — still less answer for any report, — which I never dare read; but I can tell you the amount of my chiding. I vented some of the old grudge I owe the college now for forty-five years, for the cruel waste of two years of college time on mathematics without any attempt to adapt, by skillful tutors, or by private instruction, these tasks to the capacity of slow learners. I still remember the useless pains I took, and my serious recourse to my tutor for aid which he did not know how to give me. And now I see to-day the same indiscriminate imposing of mathematics on all students during two years,— ear or no ear, you shall all learn music,— to the waste of time and health of a large part of every class. It is both natural and laudable in each professor to magnify his department, and to seek to make it the first in the world if he can. But of course this tendency must be corrected by securing in the constitution of the college a power in the head (whether singular or plural) of coördinating all the parts. Else, important departments will be overlaid, as in Oxford and in Harvard, natural history was until now. Now, it looks as if natural history would ob-

tain in time to come the like predominance as mathematics have here, or Greek at Oxford. It will not grieve me if it should, for we are all curious of nature, but not of algebra. But the necessity of check on the instructors in the head of the college, I am sure you will agree with me, is indispensable. You will see that my allusion to naturalists is only incidental to my statement of my grievance.

But I have made my letter ridiculously long, and pray you to remember that you have brought it on your own head. I do not know that I ever attempted before an explanation of any speech.

Always with entire regard yours,

R. W. EMERSON.

At about this time, in September, 1864, Agassiz made an excursion into Maine, partly to examine the drift phenomena on the islands and coast of that State, and partly to study the so-called "horse-backs." The journey proved to be one of the most interesting he had made in this country with reference to local glacial phenomena. Compass in hand, he followed the extraordinary ridges of morainic material lying between Bangor and Katahdin, to the Ebeene Mountains, at the foot

of which are the Katahdin Iron Works. Returning to Bangor, he pursued, with the same minute investigation, the glacial tracks and erratic material from that place to the sea-coast and to Mount Desert. The details of this journey and its results are given in one of the papers contained in the second volume of his "Geological Sketches." In conclusion, he says; "I suppose these facts must be far less expressive to the general observer than to one who has seen this whole set of phenomena in active operation. To me they have been for many years so familiar in the Alpine valleys, and their aspect in those regions is so identical with the facts above described, that paradoxical as the statement may seem, the presence of the ice is now an unimportant element to me in the study of glacial phenomena; no more essential than is the flesh to the anatomist who studies the skeleton of a fossil animal."

This journey in Maine, undertaken in the most beautiful season of the American year, when the autumn glow lined the forest roads with red and gold, was a great refreshment to Agassiz. He had been far from well, but he returned to his winter's work invigorated and with a new sense of hope and courage.

CHAPTER XXI.

1865–1868 : ÆT. 58–61.

Letter to his Mother announcing Journey to Brazil. — Sketch of Journey. — Kindness of the Emperor. — Liberality of the Brazilian Government. — Correspondence with Charles Sumner. — Letter to his Mother at Close of Brazil Journey. — Letter from Martius concerning Journey in Brazil. — Return to Cambridge. — Lectures in Boston and New York. — Summer at Nahant. — Letter to Professor Peirce on the Survey of Boston Harbor. — Death of his Mother. — Illness. — Correspondence with Oswald Heer. — Summer Journey in the West. — Cornell University. — Letter from Longfellow.

THE next important event in the life of Agassiz, due in the first instance to his failing health, which made some change of scene and climate necessary, is best announced by himself in the following letter.

TO HIS MOTHER.

CAMBRIDGE, *March* 22, 1865.

DEAR MOTHER, — You will shed tears of joy when you read this, but such tears are harmless. Listen, then, to what has happened. A few weeks ago I was thinking how I should

employ my summer. I foresaw that in going to Nahant I should not find the rest I need after all the fatigue of the two last years, or, at least, not enough of change and relaxation. I felt that I must have new scenes to give me new life. But where to go and what to do?

Perhaps I wrote you last year of the many marks of kindness I have received from the Emperor of Brazil, and you remember that at the time of my début as an author, my attention was turned to the natural history of that country. Lately, also, in a course of lectures at the Lowell Institute, I have been led to compare the Alps, where I have passed so many happy years, with the Andes, which I have never seen. In short, the idea came to me gradually, that I might spend the summer at Rio de Janeiro, and that, with the present facilities for travel, the journey would not be too fatiguing for my wife. . . . Upon this, then, I had decided, when most unexpectedly, and as the consummation of all my wishes, my pleasure trip was transformed into an important scientific expedition for the benefit of the Museum, by the intervention of one of my friends, Mr. Nathaniel Thayer. By chance I met him a week ago in Boston. He laughed at me a little about my roving disposition,

and then asked me what plans I had formed for the Museum, in connection with my journey. I answered that, thinking especially of my health, I had provided only for the needs of myself and my wife during an absence of six or eight months. Then ensued the following conversation.

"But, Agassiz, that is hardly like you; you have never been away from Cambridge without thinking of your Museum."

"True enough; but I am tired, — I need rest. I am going to loaf a little in Brazil."

"When you have had a fortnight of that kind of thing you will be as ready for work as ever, and you will be sorry that you have not made some preparation to utilize the occasion and the localities in the interest of the Museum."

"Yes, I have some such misgiving; but I have no means for anything beyond my personal expenses, and it is no time to ask sacrifices from any one in behalf of science. The country claims all our resources."

"But suppose some one offered you a scientific assistant, all expenses paid, what would you say?"

"Of that I had never thought."

"How many assistants could you employ?"

"Half a dozen."

"And what would be the expense of each one?"

"I suppose about twenty-five hundred dollars; at least, that is what I have counted upon for myself."

After a moment's reflection he resumed: —

"If it suits you then, Agassiz, and interferes in no way with the plans for your health, choose your assistants among the employees of your Museum or elsewhere, and I will be responsible for all the scientific expenses of the expedition." . . .

My preparations are made. I leave probably next week, from New York, with a staff of assistants more numerous, and, I think, as well chosen, as those of any previous undertaking of the kind.[1]

. . . All those who know me seem to have combined to heighten the attraction of the journey, and facilitate it in every respect. The Pacific Mail Steamship Company has invited me to take passage with my whole party on their fine steamer, the Colorado. They will take us, free of all expense, as far as Rio

[1] Beside the six assistants provided for by Mr. Thayer, there were a number of young volunteer aids who did excellent work on the expedition.

de Janeiro, — an economy of fifteen thousand francs at the start. Yesterday evening I received a letter from the Secretary of the Navy, at Washington, desiring the officers of all vessels of war stationed along the coasts I am to visit, to give me aid and support in everything concerning my expedition. The letter was written in the kindest terms, and gratified me the more because it was quite unsolicited. I am really touched by the marks of sympathy I receive, not only from near friends, but even from strangers. . . . I seem like the spoiled child of the country, and I hope God will give me strength to repay in devotion to her institutions and to her scientific and intellectual development, all that her citizens have done for me.

I am forgetting that you will be anxious to know what special work I propose to do in the interest of science in Brazil. First, I hope to make large collections of all such objects as properly belong in a Museum of Natural History, and to this end I have chosen from among the employees of our Museum one representative from each department. My only regret is that I must leave Alex. in Cambridge to take care of the Museum itself. He will have an immense amount of work to do, for

I leave him only six out of our usual staff of assistants. In the second place, I intend to make a special study of the habits, metamorphoses, anatomy, etc., of the Amazonian fishes. Finally, I dream sometimes of an ascension of the Andes, if I do not find myself too old and too heavy for climbing. I should like to see if there were not also large glaciers in this chain of mountains, at the period when the glaciers of the Alps extended to the Jura. . . . But this latter part of my plan is quite uncertain, and must depend in great degree upon our success on the Amazons. Accompanied as I am with a number of *aides naturalistes*, we ought to be able among us to bring together large collections, and even to add duplicates, which I can then, on my return, distribute to the European Museums, in exchange for valuable specimens.

We leave next week, and I hope to write you from Rio a letter which will reach you about the date of my birthday. A steamer leaves Brazil once a month for England. If my arrival coincides with her departure you shall not be disappointed in this.

With all my heart,

Your Louis.

The story of this expedition has been told in the partly scientific, partly personal diary published after Agassiz's return, under the title of "A Journey in Brazil," and therefore a full account of it here would be mere repetition. He was absent sixteen months. The first three were spent in Rio de Janeiro, and in excursions about the neighborhood of her beautiful bay and the surrounding mountains. For greater efficiency and promptness he divided his party into companies, each working separately, some in collecting, others in geological surveys, but all under one combined plan of action.

The next ten months were passed in the Amazonian region. This part of the journey had the charm of purely tropical scenery, and Agassiz, who was no less a lover of nature than a naturalist, enjoyed to the utmost its beauty and picturesqueness. Much of the time he and his companions were living on the great river itself, and the deck of the steamer was by turns laboratory, dining-room, and dormitory. Often, as they passed close under the banks of the river, or between the many islands which break its broad expanse into narrow channels, their improvised working room was overshadowed by the lofty wall

of vegetation, which lifted its dense mass of trees and soft drapery of vines on either side. Still more beautiful was it when they left the track of the main river for the water-paths hidden in the forest. Here they were rowed by Indians in "montarias," a peculiar kind of boat used by the natives. It has a thatched hood at one end for shelter from rain or sun. Little sun penetrates, however, to the shaded "igarapè" (boat-path), along which the montaria winds its way under a vault of green. When traveling in this manner, they stopped for the night, and indeed sometimes lingered for days, in Indian settlements, or in the more secluded single Indian lodges, which are to be found on the shores of almost every lake or channel. In this net-work of fresh waters, threading the otherwise impenetrable woods, the humblest habitation has its boat and landing-place. With his montaria and his hammock, his little plantation of bananas and mandioca, and the dwelling, for which the forest about him supplies the material, the Amazonian Indian is supplied with all the necessities of life.

Sometimes the party were settled, for weeks at a time, in more civilized fashion, in the towns or villages on the banks of the main

river, or its immediate neighborhood, at Manaos, Ega, Obydos, and elsewhere. Wherever they sojourned, whether for a longer or a shorter time, the scientific work went on uninterruptedly. There was not an idle member in the company.

From the time he left Rio de Janeiro, Agassiz had the companionship of a young Brazilian officer of the engineer corps, Major Coutinho. Thoroughly familiar with the Amazons and its affluents, at home with the Indians, among whom he had often lived, he was the pearl of traveling companions as well as a valuable addition to the scientific force. Agassiz left the Amazonian valley in April, and the two remaining months of his stay in Brazil were devoted to excursions along the coast, especially in the mountains back of Ceara, and in the Organ mountains near Rio de Janeiro.

From beginning to end this journey fulfilled Agassiz's brightest anticipations. Mr. Thayer, whose generosity first placed the expedition on so broad a scientific basis, continued to give it his cordial support till the last specimen was stored in the Museum. The interest taken in it by the Emperor of Brazil, and the liberality of the government toward it, also facilitated all Agassiz's aims

and smoothed every difficulty in the path. On starting he had set before himself two subjects of inquiry. These were, first, the fresh-water fauna of Brazil, of the greater interest to him, because of the work on the Brazilian Fishes, with which his scientific career had opened; and second, her glacial history, for he believed that even these latitudes must have been, to a greater or less degree, included in the ice-period. The first three months spent in Rio de Janeiro and its environs gave him the key to phenomena connected with both these subjects, and he followed them from there to the head-waters of the Amazons, as an Indian follows a trail. The distribution of life in the rivers and lakes of Brazil, the immense number of species and their local circumscription, as distinct faunæ in definite areas of the same water-basin, amazed him; while the character of the soil and other geological features confirmed him in his preconceived belief that the glacial period could not have been less than cosmic in its influence. He was satisfied that the tropical, as well as the temperate and arctic regions, had been, although in a less degree, fashioned by ice.

Just before leaving the United States he received a letter of friendly farewell from

Charles Sumner, and his answer, written on the Rio Negro, gives some idea of the conditions under which he traveled, and of the results he had obtained. As the letters explain each other, both are given here.

FROM CHARLES SUMNER.

WASHINGTON, *March* 20, 1865.

MY DEAR AGASSIZ, — It is a beautiful expedition that you are about to commence, — in contrast with the deeds of war. And yet you are going forth to conquer new realms, and bring them under a sway they have not yet known. But science is peaceful and bloodless in her conquests. May you return victorious! I am sure you will. Of course you will see the Emperor of Brazil, whose enlightened character is one of the happy accidents of government. . . . You are a naturalist; but you are a patriot also. If you can take advantage of the opportunities which you will surely enjoy, and plead for our country, to the end that its rights may be understood, and the hardships it has been obliged to endure may be appreciated, you will render a service to the cause of international peace and good-will.

You are to have great enjoyment. I imagine you already very happy in the scenes be-

fore you. I, too, should like to see Nature in her most splendid robes; but I must stay at home and help keep the peace. Good-by — Bon voyage!

Ever sincerely yours,

CHARLES SUMNER.

TO CHARLES SUMNER.

RIO NEGRO; ON BOARD THE BRAZILIAN WAR STEAMER IBICUHY, *December* 26, 1865.

MY DEAR SUMNER, — The heading of these lines tells a long and interesting story. Here I am, sailing on the Rio Negro, with my wife and a young Brazilian friend, provided with all the facilities which modern improvements, the extraordinary liberality of the Brazilian government, and the kindness of our commander can bestow, and pursuing my scientific investigations with as much ease as if I were in my study, or in the Museum at Cambridge, — with this enormous difference, that I am writing on deck, protected by an awning from the hot sun, and surrounded by all the luxuriance of the richest tropical vegetation.

The kind reception I met at the hands of the emperor on my arrival at Rio has been followed by every possible attention and mark of good-will toward me personally, but usually

tendered in such a way as to show that an expression of cordiality toward the United States was intended also in the friendly feeling with which everything was done to facilitate my researches. In the first place, the emperor gave me as a traveling companion an extremely intelligent and well-educated Brazilian, the man of all others whom I should have chosen had I been consulted beforehand; and for the six months during which we have been on our journey here, I have not been able to spend a dollar except for my personal comfort, and for my collections. All charges for transportation of persons and baggage in public conveyances, as well as for specimens, have everywhere been remitted by order of the government. This is not all; when we reached Parà the Brazilian Steamship Company placed a steamer at my disposal, that I might stop where I pleased on the way, and tarry as long as I liked instead of following the ordinary line of travel. In this way I ascended the Amazons to Manaos, and from there, by the ordinary steamer, reached the borders of Peru, making prolonged stays at Manaos and at Ega, and sending out exploring parties up the Javary, the Jutay, the Ica, etc. On my return to Manaos, at the junction of the Rio Negro and the

Amazons, I found the Ibicuhy awaiting me with an order from the Minister of Public Works, placing her at my disposal for the remainder of my stay in the waters of the Amazons.

The Ibicuhy is a pretty little war steamer of 120 horse power, carrying six thirty-two pound guns. On board of her, and in company with the President of the Province, I have already visited that extraordinary network of river anastomoses and lakes, stretching between the river Madeira and the Amazons to the river Tapajos, and now I am ascending the Rio Negro, with the intention of going up as far as the junction of the Rio Branco with the Rio Negro. That the Brazilian government should be able and willing to offer such facilities for the benefit of science, during a time of war, when all the resources of the nation are called upon in order to put an end to the barbarism of Paraguay, is a most significant sign of the tendencies prevailing in the administration. There can be no doubt that the emperor is the soul of the whole. This liberality has enabled me to devote all my resources to the making of collections, and the result of my researches has, of course, been proportionate to the facilities I

have enjoyed. Thus far, the whole number of fishes known from the Amazons has amounted to a little over one hundred, counting everything that may exist from these waters, in the Jardin des Plantes, the British Museum, the museums of Munich, Berlin, Vienna, etc.; while I have collected and now hold, in good state of preservation, fourteen hundred and forty-two species, and may get a few hundred more before returning to Parà. I have so many duplicates that I may make every other museum tributary to ours, so far as the fresh-water animals of Brazil are concerned. This may seem very unimportant to a statesman. But I am satisfied that it affords a standard by which to estimate the resources of Brazil, as they may be hereafter developed. The basin of the Amazons is another Mississippi, having a tropical climate, tempered by moisture. Here is room for a hundred million happy human beings.

Ever truly your friend,

L. AGASSIZ.

The repose of the return voyage, after sixteen months of such uninterrupted work, and of fresh impressions daily crowding upon each other, was most grateful to Agassiz. The

summary of this delightful journey may close as it began with a letter to his mother.

At Sea, *July* 7, 1866.

Dear Mother, — When you receive this letter we shall be, I hope, at Nahant, where our children and grandchildren are waiting for us. To-morrow we shall stop at Pernambuco, where I shall mail my letter to you by a French steamer.

I leave Brazil with great regret. I have passed nearly sixteen months in the uninterrupted enjoyment of this incomparable tropical nature, and I have learned many things which have enlarged my range of thought, both concerning organized beings and concerning the structure of the earth. I have found traces of glaciers under this burning sky; a proof that our earth has undergone changes of temperature more considerable than even our most advanced glacialists have dared to suggest. Imagine, if you can, floating ice under the equator, such as now exists on the coasts of Greenland, and you will probably have an approximate idea of the aspect of the Atlantic Ocean at that epoch.

It is, however, in the basin of the Amazons especially, that my researches have been crowned

with an unexpected success. Spix and Martius, for whose journey I wrote, as you doubtless remember, my first work on fishes, brought back from there some fifty species, and the sum total known now, taking the results of all the travelers who have followed up the inquiry, does not amount to two hundred. I had hoped, in making fishes the special object of my researches, to add perhaps a hundred more. You will understand my surprise when I rapidly obtained five or six hundred, and finally, on leaving Parà, brought away nearly two thousand, — that is to say, ten times more than were known when I began my journey.[1] A great part of this success is due to the unusual facilities granted me by the Brazilian government. . . . To the Emperor of Brazil I owe the warmest gratitude. His kindness to me has been beyond all bounds. . . . He even made for me, while he was with the army last summer, a collection of fishes from the

[1] This estimate was made in the field when close comparison of specimens from distant localities was out of the question. The whole collection has never been worked up, and it is possible that the number of new species it contains, though undoubtedly greatly in excess of those previously known from the Amazons, may prove to be less than was at first supposed. — Ed.

province of Rio Grande du Sud. This collection would do honor to a professional naturalist. . . .

Good-by, dear mother.

With all my heart,

Your Louis.

The following letter from old Professor Martius in Munich, of uncertain date, but probably in answer to one of March, 1866, is interesting, as connecting this journey with his own Brazilian expedition almost half a century before.

FROM PROFESSOR MARTIUS.

February 26, 1867.

My dear Friend, — Your letter of March 20th last year was most gratifying to me as a token of your affectionate remembrance. You will easily believe that I followed your journey on the Amazons with the greatest interest, and without any alloy of envy, though your expedition was undertaken forty years later than mine, and under circumstances so much more favorable. Bates, who lived for years in that country, has borne me witness that I was not wanting in courage and industry during an exploration which lasted eleven months; and I therefore believe that you also, in reviewing

on the spot my description of the journey, will not have passed an unfavorable judgment. Our greatest difficulty was the small size of our boat which was so weak as to make the crossing of the river always dangerous. I shall look forward with great pleasure to the more detailed account of your journey, and also the plan of your route, which I hope you will send me. Can you tell me anything about the human skeletons at the Rio St. Antonio in St. Paul? I am very glad to know that you have paid especial attention to the palms, and I entreat you to send me the essential parts of every species which you hold to be new, because I wish to work out the palms for the Flora Brasiliensis this year. I wish I might find among them some new genus or species, which then should bear your name.

Do you intend to publish an account of your journey, or shall you confine yourself entirely to a report on your observations on Natural History? With a desire to explain the numerous names of animals, plants, and places, which are derived from the Tupèe language, I have studied it for years that I might be able to use it fluently. Perhaps you have seen my "Glossaria lignareus brasiliensium." It contains also 1150 names of animals. To this work belong, likewise, my ethnographical

contributions, of which forty-five sheets are already printed, to be published I hope next year. I am curious to hear your geological conclusions. I am myself inclined to the belief that men existed in South America previous to the latest geological catastrophes. As you have seen so many North American Indians, you will be able to give interesting explanations of their somatic relations to the South American Indians. Why could you not send me, as secretary of the mathematical and physical section, a short report of your principal results? It would then be printed in the report of our meetings, which, as the forerunner of other publications, could hardly fail to be agreeable to you. You no doubt see our friend Asa Gray occasionally. Remember me cordially to him, and tell him I look eagerly for an answer to my last letter. The year 'sixty-six has taken from us many eminent botanists, Gusone, Mettenius, Von Schlechtendal, and Fresenius. I hear but rarely from our excellent friend Alexander Braun. He does not resist the approach of old age so well as you, my dear friend. You are still the active naturalist, fresh and well preserved, to judge by your photograph. Thank you for it; I send mine in return. My wife still holds in warm remembrance the days when you, a bright,

pleasant young fellow, used to come and see us, — what a long stretch of time lies between. Much is changed about me. Of former friends only Kobell and Vogel remain; Zuccarini, Wagner, Oken, Schelling, Sieber, Fuchs, Walther, — all these have gone home. All the pleasanter is it that you, on the other side of the ocean, think sometimes of your old friend, to whom a letter from you will be always welcome. Remember me to your family, though I am not known to them. May the present year bring you health, cheerfulness, and the full enjoyment of your great and glorious success.

With warm esteem and friendship, always yours,

MARTIUS.

Agassiz arrived in Cambridge toward the end of August, 1866. After the first excitement of meeting family and friends was over, he took up his college and museum work again. He had left for Brazil at the close of a course before the Lowell Institute, and his first public appearance after his return was on the same platform. The rush for tickets was far in excess of the supply, and he was welcomed with the most ardent enthusiasm. It continued unabated to the close, although the

lectures borrowed no interest from personal adventure or incidents of travel, but dealt almost wholly with the intellectual results and larger scientific generalizations growing out of the expedition. Later in the winter he gave a course also at the Cooper Institute, in New York, which awakened the same interest and drew crowds of listeners. The resolution offered by Bancroft, the historian, at the close of the course, gives an idea of its character, and coming from such a source, may not unfitly be transcribed here.

Resolved, That the thanks of this great assembly of delighted hearers be given to the illustrious Professor Agassiz, for the fullness of his instruction, for the clearness of his method of illustration, for his exposition of the idea as antecedent to form; of the superiority of the undying, original, and eternal force over its transient manifestations; for happy hours which passed too rapidly away; for genial influences of which the memory will last through our lives.

All his leisure hours during the winter of 1867 were given to the review and arrangement of the great collections he had brought home.

TO SIR PHILIP DE GREY EGERTON.

MUSEUM OF COMPARATIVE ZOÖLOGY,
CAMBRIDGE, MASS., *March* 26, 1867.

. . . I know you will be pleased to hear that I have returned to the study of fishes, and that I am not likely to give it up again for years to come. My success in collecting in the Amazons has been so unexpected that it will take me years to give an account of what I have found, and I am bound to show that the strange statements that have gone abroad are strictly correct. Yes, I have about eighteen hundred new species of fishes from the basin of the Amazons! The collection is now in Cambridge, for the most part in good preservation. It suggests at once the idea that either the other rivers of the world have been very indifferently explored, or that tropical America nourishes a variety of animals unknown to other regions. In this dilemma it would be worth while to send some naturalist to investigate the Ganges or the Bramaputra, or some of the great Chinese rivers. Can it not be done by order of the British government?

Please send me whatever you may publish upon the fossil fishes in your possession. I

frequently sigh for another session in your museum, and it is not improbable that I shall solicit an invitation from you in a few years, in order to revise my views of the whole subject in connection with what I am now learning of the living fishes. By the way, I have eleven hundred colored drawings of the species of Brazil made from life by my old friend Burkhardt, who accompanied me on this journey.

My recent studies have made me more adverse than ever to the new scientific doctrines which are flourishing now in England. This sensational zeal reminds me of what I experienced as a young man in Germany, when the physio-philosophy of Oken had invaded every centre of scientific activity; and yet, what is there left of it? I trust to outlive this mania also. As usual, I do not ask beforehand what you think of it, and I may have put my hand into a hornet's nest; but you know your old friend Agass., and will forgive him if he hits a tender spot. . . .

The summer of 1867 was passed very tranquilly at his Nahant laboratory, in that quiet work with his specimens and his microscope which pleased him best. The following letter

to Professor Benjamin Peirce, who was then Superintendent of the Coast Survey, shows, however, his unfailing interest in the bearing of scientific researches on questions of public utility.

TO PROFESSOR PEIRCE, SUPERINTENDENT OF THE COAST SURVEY.

NAHANT, *September* 11, 1867.

DEAR SIR, — Far from considering your request a tax upon my time, it gives me the greatest pleasure to have an opportunity of laying before you some statements and reflections, which I trust may satisfy you that geology and natural history can be made subservient to the great interests of a civilized community, to a far greater extent than is generally admitted.

The question of the harbor of Boston, for instance, has a geological and zoölogical side, thus far only indirectly considered. In order to ascertain whence the materials are derived which accumulate in the harbor, the shores ought to be studied geologically with a kind of accuracy and minuteness, never required by geological surveys made for economical purposes. The banks of the harbor, wherever it is not rock-bound, consist of drift, which it

self rests upon the various rock formations of the district. Now this drift, as I have ascertained, formerly extended many miles beyond our present shores, and is still slowly washed away by the action of tides, winds, and currents. Until you know with precision the mineralogical composition of the drift of the immediate vicinity, so accurately indeed as to be able to recognize it in any new combination into which it may be brought when carried off by the sea, all your examination of soundings may be of little use. Should it, however, be ascertained that the larger amount of loose material spreading over the harbor is derived from some one or other of the drift islands in the bay, the building of sea-walls to stop the denudation may be of greater and more immediate use than any other operation. Again, it is geologically certain that all the drift islands of the harbor have been formed by the encroachment of the sea upon a sheet of drift, which once extended in unbroken continuity from Cape Ann to Cape Cod and farther south. This sheet of drift is constantly diminishing, and in centuries to come, which, notwithstanding the immeasurable duration of geological periods, may be reached, I trust, while the United States still remains a flour-

ishing empire, it will be removed still further; so far indeed, that I foresee the time when the whole peninsula of Cape Cod shall disappear. Under these circumstances, it is the duty of a wise administration to establish with precision the rate and the extent of this destruction, that the coming generations may be forewarned. In connection with this I would advise the making of a thorough survey of the harbor, to ascertain the extent of rock surface and of drift, and the relative position of the two, with maps to show their relations to the different levels of the sea, whereby the unequal action of the tides upon the various beaches may be estimated.

The zoölogical side of the question relates to the amount of loose materials accumulating in consequence of the increase of animal and vegetable life, especially of those microscopic beings which, notwithstanding their extraordinary minuteness, form in course of time vast deposits of solid materials. Ehrenberg has shown that the harbor of Wismar, on the Prussian coast of the Baltic, is filling, not in consequence of the accumulation of inorganic sediments, but by the rapid increase and decay of innumerable animalcules. To what extent such deposits may accumulate has also been shown

by Ehrenberg, who ascertained, many years ago, that the city of Berlin rests upon a deposit of about eighteen feet in thickness, consisting almost exclusively of the solid parts of such microscopic beings. These two cases may suffice to show how important may be a zoölogical investigation of the harbor deposits.

I need hardly add that the deposits floated into the harbor, by the numerous rivers and creeks which empty into it, ought to be investigated with the same care and minuteness as the drift materials. This investigation should also include the drainage of the city.

But this is only a small part of the application I would recommend to be made of geological and zoölogical knowledge, to the purposes of the Coast Survey. The reefs of Florida are of the deepest interest, and the mere geodetic and hydrographic surveys of their whole range would be far from exhausting the subject. It is my deliberate opinion that the great reefs of Florida should be explored with as much minuteness and fullness as the Gulf Stream, and that the investigation will require as much labor as has thus far been bestowed on the Gulf Stream. Here again geological and zoölogical knowledge is

indispensable to the completion of the work. The reef is formed mainly by the accumulation of solid materials from a variety of animals and a few plants. The relations of these animals and plants to one another while alive, in and upon the reef, ought to be studied more fully than has been the case heretofore, in order to determine with certainty the share they have in the formation of these immense submarine walls so dangerous to navigation. The surveys, as they have been made thus far, furnish only the necessary information concerning the present form and extent of the reef. But we know that it is constantly changing, increasing, enlarging, spreading, rising in such a way and at such a rate, that the surveys of one century become insufficient for the next. A knowledge of these changes can only be obtained by a naturalist, familiar with the structure and mode of growth of the animals. The survey I made about fifteen years ago, at the request of your lamented predecessor, could only be considered as a reconnaissance, in view of the extent and importance of the work. I would, therefore, recommend you to organize a party specially detailed to carry on these investigations in connection with, and by the side of,

the regular geodetic and hydrographic survey. Here, also, would geological knowledge be of great advantage to the explorer. In confirmation of my recommendation I need only remind you of a striking fact in the history of our science. More than thirty years ago, before Dana and Darwin had published their beautiful investigations upon the coral reefs, a pupil of mine, the late Armand Gressly, had traced the structure and mode of growth of coral reefs and atolls in the Jura mountains, thus anticipating, by a geological investigation, results afterward obtained by dredging in the ocean. The structure of the reefs of our shores is, therefore, more likely to be fully understood by one who is entirely familiar with zoölogy and geology than by a surveyor who has no familiarity with either of these sciences.

There is another reason why I would urge upon you the application of natural sciences to the work of the survey. The depth of the ocean is a great obstacle to a satisfactory exploration of its bottom. But we know now that nearly all dry land has been sea bottom before it was raised above the level of the water. This is at least the case with all the stratified rocks and aqueous deposits form-

ing part of the earth's crust. Now it would greatly facilitate the study of the bottom of the sea if, after ascertaining by soundings the general character of the bottom in any particular region, corresponding bottoms on dry land were examined, so that by a comparison of the one with the other, both might be better understood. The shoals of the southern coast of Massachusetts have been surveyed, and their position is now known with great accuracy; but their internal structure, their mode of formation, is only imperfectly ascertained, owing to the difficulty of cutting into them and examining *in situ* the materials of which they are composed. Nothing, on the contrary, is easier than to explore the structure or composition of drift hills which are cut through by all our railroad tracks. Now the shoals and rips of Nantucket have their counterparts on the main-land; and even along the shores of Boston Harbor, in the direction of Dorchester and Milton, such shoals may be examined, far away from the waters to which they owe their deposits. Here, then, is the place to complete the exploration, for which soundings and dredgings give only imperfect information.

I need not extend these remarks further in

order to satisfy you of the importance of geological and zoölogical researches in connection with the regular operations of the Coast Survey. Permit me, however, to add a few words upon some points which, as it seems to me, belong legitimately to the Coast Survey, and to which sufficient attention has not yet been paid. I allude, first, to the salt marshes of our shores, their formation and uses, as well as their gradual disappearance under the advance of the sea; second, to the extended low islands in the form of reefs along the coast of the Southern States, the bases of which may be old coral reefs; third, the form of all our estuaries, which has resulted from the conflict of the sea with the drift formation, and is therefore, in a measure, a geological problem; fourth, the extensive deposits of foraminifera along the coast, which ought to be compared with the deposits of tripoli found in many tertiary formations; fifth, the general form and outline of our continent, with all its indentations, which are due to their geological structure. Indeed, the shore everywhere is the result of the conflict of the ocean with the rock formation of the land, and therefore as much a question for geology as geodesy to answer.

Should the preceding remarks induce you to carry my suggestions into practical operation, be assured that it will at all times give me the greatest pleasure to contribute to the success of your administration, not only by advice, but by actual participation in your work whenever that is wanted. The scientific men of America look to you for the publication of the great results already secured by the Coast Survey, well knowing that this national enterprise can only be benefited by the high-minded course which has at all times marked your intellectual career.

Ever truly your friend,

L. AGASSIZ.

This year closed for Agassiz with a heavy sorrow. His mother's health had been failing of late, and November brought the news of her death. Separated though they were, there had never been any break in their intercourse. As far as he could, he kept her advised of all his projects and undertakings, and his work was no less interesting to her when the ocean lay between them than when he could daily share it with her. She had an unbounded sympathy with him in the new ties he had formed in this country, and seemed indeed as

intimately allied with his later life here as with its earlier European portion.

His own health, which had seemed for a time to have regained the vigor of youth, broke down again in the following spring, and an attack about the region of the heart disabled him for a number of weeks. To this date belongs a short correspondence between Agassiz and Oswald Heer. Heer's work on the Fossil Flora of the Arctics had recently appeared, and a presentation copy from him reached Agassiz as he was slowly regaining strength after his illness, although still confined to the house. It could not have come at a happier moment, for it engrossed him completely, and turned his thoughts away from the occupations which he was not yet allowed to resume. The book had a twofold interest for him: although in another branch of science, it was akin to his own earlier investigations, inasmuch as it reconstructed the once rich flora of the polar regions as he himself had reconstructed the fauna of past geological times; it clothed their frozen fields with forests as he had sheeted now fertile lands with ice. In short, it appealed powerfully to the imagination, and no child in the tedious hours of convalescence was ever more beguiled by a

story-book than he by the pictures which this erudite work called up.

AGASSIZ TO OSWALD HEER.

CAMBRIDGE, *May* 12, 1868.

MY HONORED COLLEAGUE, — Your beautiful book on the Fossil Arctic Flora reached me, just as I was recovering from a tedious and painful illness. I could, therefore, take it in hand at once, and have been delighted with it. You give a captivating picture of the successive changes which the Arctic regions have undergone. No work could be more valuable, either as a means of opening recent investigations in Paleontology to the larger public, or of advancing science itself. If I can find the time I mean to prepare an abridgment in popular form for one of our reviews. Meantime I have written to Professor Henry, Superintendent of the Smithsonian Institution at Washington, that he should subscribe for a number of copies to be distributed among less wealthy establishments. I hope he will do this, and I shall continue to urge it, since my friendly relations with him give me a right so to do. I have, moreover, written to the directors of various prominent institutions, in order that your work, so far as is possible for works

of that kind, may become known in the United States, and reach such persons as would naturally be interested in it. . . .

With friendly remembrance, yours always,

LOUIS AGASSIZ.

The answer is some months later in date, but is given here for its connection.

FROM OSWALD HEER.

ZURICH, *December* 8, 1868.

MY HONORED FRIEND, — Your letter of last May gave me the greatest pleasure, and I should have answered it earlier had I not heard that you had gone to the Rocky Mountains, and supposed, therefore, that my letter would hardly find you at home again before the late autumn. I will delay writing no longer, — the more so because I have received, through the Smithsonian Institution, your great work on the Natural History of the United States. Valuable as it is in itself, it has a double attraction for me as the gift of the author. Accept my warm thanks. It will always be to me a token of your friendly regard. It gave me great satisfaction to know that my Fossil Arctic Flora had met with your approval. Since then many new facts have

come to light tending to confirm my results. The Whymper Expedition brought to England a number of fossil plants, which have been sent to me for examination. I found eighty species, of which thirty-two from North Greenland are new, so that we now know 137 species of Miocene plants from North Greenland (70° N. lat). It was a real delight to me to find the fruit cup of the Castanea [chestnut] inclosing three seeds (three Kastanica) and covered with prickles like the Castanea vesca; and, furthermore, I was able to prove by the flowers, which were preserved with the fruit, that the supposition given in the Arctic Flora (p. 106) was correct; namely, that the leaves of the Fagus castaneafolia Ung. truly belong to a Castanea. As several fruits are contained in one fruit cup, this Miocene Castanea must have been nearer to the European species (C. vesca) than to the American Castanea (the C. pumila Micha). The leaves have been drawn in the Flora Arctica, and are also preserved in the Whymper collection.

I have received very beautiful and large leaves of the Castanea which I have called C. Ungeri, from Alaska. I am now occupied in working up this fossil Alaskan flora; the plants are in great part drawn, and contain

magnificent leaves. The treatise will be published by the Swedish Academy in Stockholm; I hope to send you a copy a few months hence. This flora is remarkable for its resemblance to the European Miocene flora. The liquidambar, as well as several poplars and willows, cannot be distinguished from those of Oeningen; the same is true of an Elm, a Carpinus, and others. As Alaska now belongs to the United States, it is to be hoped that these collecting stations, which have already furnished such magnificent plants, will be farther ransacked. . . . Hoping that you have returned safely from your journey, and that these lines may find you well, I remain, with cordial greeting, Sincerely yours,

OSWALD HEER.

Shortly after Agassiz's recovery, in July, 1868, he was invited by Mr. Samuel Hooper to join a party of friends, tired members of Congress and business men, on an excursion to the West, under conditions which promised not only rest and change, but an opportunity for studying glacial phenomena over a broad region of prairie and mountain which Agassiz had never visited. They were to meet at Chicago, keep on from there to St. Paul, and

down the Mississippi, turning off through Kansas to the eastern branch of the Pacific Railroad, at the terminus of which they were to meet General Sherman with ambulances and an escort for conveyance across the country to the Union Pacific Railroad, returning then by Denver, Utah, and Omaha, and across the State of Iowa to the Mississippi once more. This journey was of great interest to Agassiz, and its scientific value was heightened by a subsequent stay of nearly two months at Ithaca, N. Y., on his return. Cornell University was then just opened at Ithaca, and he had accepted an appointment as non-resident professor, with the responsibility of delivering annually a course of lectures on various subjects of natural history. New efforts in behalf of education always attracted him, and this drew him with an even stronger magnet than usual, involving as it did an untried experiment — the attempt, namely, to combine the artisan with the student, manual labor with intellectual work. The plan was a generous one, and stimulated both pupils and teachers. Among the latter none had greater sympathy with the high ideal and broad humanity of the undertaking than Agassiz.[1]

[1] Very recently a memorial tablet has been placed in the

Beside the enthusiasm which he brought to his special work, he found an added pleasure at Cornell in the fact that the region in which the new university was situated contained another chapter in the book of glacial records he had so long been reading, and made also, as the following letter tells us, a natural sequence to his recent observations in the West.

TO M. DE LA RIVE.

ITHACA, *October* 26, 1868.

. . . I am passing some weeks here, and am studying the erratic phenomena, and especially the formation of the many small lakes which literally swarm in this region, and are connected in various ways with the glacial epoch. The journey which I have just completed has furnished me with a multitude of new facts concerning the glacial period, the long continuance of which, and its importance with reference to the physical history of the globe, become daily more clear to me. The origin and mode of formation of the vast system of our American rivers have especially occupied me, and I think I have found the solution of

Chapel at Cornell University by the trustees, recording their gratitude for the share he took in the initiation of the institution.

the problem which they present. This system reproduces the lines followed by the water over the surface of the ground moraines, which covered the whole continent, when the great sheet of ice which modeled the drift broke up and melted away. This conclusion will, no doubt, be as slow of acceptance as was the theory of the ancient extension of glaciers. But that does not trouble me. For my own part I am confident of its truth, and after having seen the idea of a glacial epoch finally adopted by all except those who are interested in opposing it on account of certain old and artificial theories, I can wait a little till the changes which succeeded that epoch are also understood. I have obtained direct proof that the prairies of the West rest upon polished rock. It has happened in the course of recent building on the prairie, that the native rock has been laid bare here and there, and this rock is as distinctly furrowed by the action of the glacier and by its engraving process, as the Handeck, or the slopes of the Jura. I have seen magnificent slabs in Nebraska in the basin of the river Platte. Do not the physicists begin to think of explaining to us the probable cause of changes so remarkable and so well estab-

lished? We can no longer evade the question by supposing these phenomena to be due to the action of great currents. We have to do first with sheets of ice, five or six thousand feet in thickness (an estimate which can be tested by indirect measurements in the Northern States), covering the whole continent, and then with the great currents which ensued upon the breaking up of that mass of ice. He who does not distinguish between these two series of facts, and perceive their connection, does not understand the geology of the Quaternary epoch. . . .

Of about this date is the following pleasant letter from Longfellow to Agassiz. Although it has no special bearing upon what precedes, it is inserted here, because their near neighborhood and constant personal intercourse, both at Cambridge and Nahant, made letters rare between them. Friends who see each other so often are infrequent correspondents.

ROME, *December* 31, 1868.

MY DEAR AGASSIZ, — I fully intended to write you from Switzerland, that my letter might come to you like a waft of cool air from a glacier in the heat of summer. But

alas! I did not find cool air enough for myself, much less to send across the sea. Switzerland was as hot as Cambridge, and all life was taken out of me; and the letter remained in the inkstand. I draw it forth as follows.

One of the things I most wished to say, and which I say first, is the delight with which I found your memory so beloved in England. At Cambridge, Professor Sedgwick said, "Give my love to Agassiz. Give him the blessing of an old man." In London, Sir Roderick Murchison said, "I have known a great many men that I liked; but I *love* Agassiz." In the Isle of Wight, Darwin said, "What a set of men you have in Cambridge! Both our universities put together cannot furnish the like. Why, there is Agassiz, — he counts for three."

One of my pleasantest days in Switzerland was that passed at Yverdon. In the morning I drove out to see the Gasparins. In their abundant hospitality they insisted upon my staying to dinner, and proposed a drive up the valley of the Orbe. I could not resist; so up the lovely valley we drove, and passed the old chateau of the Reine Berthe, one of my favorite heroines, but, what was far more to me, passed the little town of Orbe. There it

stands, with its old church tower and the trees on the terrace, just as when you played under them as a boy. It was very, very pleasant to behold. . . . Thanks for your letter from the far West. I see by the papers that you have been lecturing at the Cornell University.

With kindest greetings and remembrances, always affectionately yours,

H. W. L.

CHAPTER XXII.

1868–1871 : ÆT. 61–64.

New Subscription to Museum. — Additional Buildings. — Arrangement of New Collections. — Dredging Expedition on Board the Bibb. — Address at the Humboldt Centennial. — Attack on the Brain. — Suspension of Work. — Working Force at the Museum. — New Accessions. — Letter from Professor Sedgwick. — Letter from Professor Deshayes. — Restored Health. — Hassler Voyage proposed. — Acceptance. — Scientific Preparation for the Voyage.

AGASSIZ returned to Cambridge to find the Museum on an improved footing financially. The Legislature had given seventy-five thousand dollars for an addition to the building, and private subscriptions had doubled this sum, in order to provide for the preservation and arrangement of the new collections. In acknowledging this gift of the Legislature in his Museum Report for 1868 Agassiz says : —

"While I rejoice in the prospect of this new building, as affording the means for a complete exhibition of the specimens now stored in our cellars and attics and encumbering every room of the present edifice, I yet

can hardly look forward to the time when we shall be in possession of it without shrinking from the grandeur of our undertaking. The past history of our science rises before me with its lessons. Thinking men in every part of the world have been stimulated to grapple with the infinite variety of problems, connected with the countless animals scattered without apparent order throughout sea and land. They have been led to discover the affinities of various living beings. The past has yielded up its secrets, and has shown them that the animals now peopling the earth are but the successors of countless populations which have preceded them, and whose remains are buried in the crust of our globe. Further study has revealed relations between the animals of past time and those now living, and between the law of succession in the former and the laws of growth and distribution in the latter, so intimate and comprehensive that this labyrinth of organic life assumes the character of a connected history, which opens before us with greater clearness in proportion as our knowledge increases. But when the museums of the Old World were founded, these relations were not even suspected. The collections of natural history, gathered at im-

mense expense in the great centres of human civilization, were accumulated mainly as an evidence of man's knowledge and skill in exhibiting to the best advantage, not only the animals, but the products and curiosities of all sorts from various parts of the world. While we admire and emulate the industry and perseverance of the men who collected these materials, and did in the best way the work it was possible to do in their time for science, we have no longer the right to build museums after this fashion. The originality and vigor of one generation become the subservience and indolence of the next, if we only repeat the work of our predecessors. They prepared the ground for us by accumulating the materials for extensive comparison and research. They presented the problem; we ought to be ready with the solution. If I mistake not, the great object of our museums should be to exhibit the whole animal kingdom as a manifestation of the Supreme Intellect. Scientific investigation in our day should be inspired by a purpose as animating to the general sympathy, as was the religious zeal which built the Cathedral of Cologne or the Basilica of St. Peter's. The time is passed when men expressed their deepest convictions by these

wonderful and beautiful religious edifices; but it is my hope to see, with the progress of intellectual culture, a structure arise among us which may be a temple of the revelations written in the material universe. If this be so, our buildings for such an object can never be too comprehensive, for they are to embrace the infinite work of Infinite Wisdom. They can never be too costly, so far as cost secures permanence and solidity, for they are to contain the most instructive documents of Omnipotence."

Agassiz gave the winter of 1869 to identifying, classifying, and distributing the new collections. A few weeks in the spring were, however, passed with his friend Count de Pourtalès in a dredging expedition on board the Coast Survey Steamer Bibb, off the coast of Cuba, on the Bahama Banks, and among the reefs of Florida. This dredging excursion, though it covered a wider ground than any previous one, was the third deep-sea exploration undertaken by M. de Pourtalès under the auspices of the Coast Survey. His investigations may truly be said to have exercised a powerful influence upon this line of research, and to have led the way to the more extended work of the same kind carried on

by the Coast Survey in later years. He had long wished to show his old friend and teacher some of the rich dredging grounds he had discovered between Florida and the West Indies, and they thoroughly enjoyed this short period of work together. Every day and hour brought some new interest, and excess of material seemed the only difficulty.

This was Agassiz's last cruise in the Bibb, on whose hospitable deck he had been a welcome guest from the first year of his arrival in this country. The results of this expedition, as connected with the present conformation of the continent and its probable geological history in the past, were given as follows in the Museum Bulletin of the same year.

REPORT UPON DEEP SEA DREDGINGS.[1]

BY LOUIS AGASSIZ.

From what I have seen of the deep-sea bottom, I am already led to infer that among the rocks forming the bulk of the stratified crust of our globe, from the oldest to the youngest formation, there are probably none which have been formed in very deep waters. If this be so, we shall have to admit that the areas now respectively occupied by our continents, as

[1] *Bull. Mus. Comp. Zoöl.*, I. No. 13, 1869, pp. 368, 369.

circumscribed by the two hundred fathom curve or thereabout, and the oceans at greater depth, have from the beginning retained their relative outline and position; the continents having at all times been areas of gradual upheaval with comparatively slight oscillations of rise and subsidence, and the oceans at all times areas of gradual depression with equally slight oscillations. Now that the geological constitution of our continent is satisfactorily known over the greatest part of its extent, it seems to me to afford the strongest evidence that this has been the case; while there is no support whatever for the assumption that any part of it has sunk again to any very great depth after its rise above the surface of the ocean. The fact that upon the American continent, east of the Rocky Mountains, the geological formations crop out in their regular succession, from the oldest azoic and primordial deposits to the cretaceous formation, without the slightest indication of a great subsequent subsidence, seems to me the most complete and direct demonstration of my proposition. Of the western part of the continent I am not prepared to speak with the same confidence. Moreover, the position of the cretaceous and tertiary formations along

the low grounds east of the Alleghany range is another indication of the permanence of the ocean trough, on the margin of which these more recent beds have been formed. I am well aware that in a comparatively recent period, portions of Canada and the United States, which now stand six or seven hundred feet above the level of the sea, have been under water; but this has not changed the configuration of the continent, if we admit that the latter is in reality circumscribed by the two hundred fathom curve of depth.

The summer was passed in his beloved laboratory at Nahant (as it proved, the last he ever spent there), where he was still continuing the preparation of his work on sharks and skates. At the close of the summer, he interrupted this occupation for one to which he brought not only the reverence of a disciple, but a life-long debt of personal gratitude and affection. He had been entreated to deliver the address at the Humboldt Centennial Celebration (September 15, 1869), organized under the auspices of the Boston Society of Natural History. He had accepted the invitation with many misgivings, for to literary work as such he was unaccustomed, and in

the field of the biographer he felt himself a novice. His preparation for the task was conscientious and laborious. For weeks he shut himself up in a room of the Public Library in Boston and reviewed all the works of the great master, living, as it were, in his presence. The result was a very concise and yet full memoir, a strong and vigorous sketch of Humboldt's researches, and of their influence not only upon higher education at the present day, but on our most elementary instruction, until the very "school-boy is familiar with his methods, yet does not know that Humboldt is his teacher." Agassiz's picture of this generous intellect, fertilizing whatever it touched, was made the more life-like by the side lights which his affection for Humboldt and his personal intercourse with him in the past enabled him to throw upon it. Emerson, who was present, said of this address, "that Agassiz had never delivered a discourse more wise, more happy, or of more varied power." George William Curtis writes of it: "Your discourse seems to me the very ideal of such an address, — so broad, so simple, so comprehensive, so glowing, so profoundly appreciative, telling the story of Humboldt's life and work as I am sure no other living man can tell it."

In memory of this occasion the "Humboldt Scholarship" was founded at the Museum of Comparative Zoölogy.

It is hardly worth while to consider now whether this effort, added to the pressing work of the year, hastened the attack which occurred soon after, with its warning to Agassiz that his overtasked brain could bear no farther strain. The first seizure, of short duration, but affecting speech and motion while it lasted, was followed by others which became less and less acute until they finally disappeared. For months, however, he was shut up in his room, absolutely withdrawn from every intellectual effort, and forbidden by his physicians even to think. The fight with his own brain was his greatest difficulty, and perhaps he showed as much power in compelling his active intellect to stultify itself in absolute inactivity for the time, as he had ever shown in giving it free rein. Yet he could not always banish the Museum, the passionate dream of his American life. One day, after dictating some necessary directions concerning it, he exclaimed, with a sort of despairing cry, "Oh, my Museum! my Museum! always uppermost, by day and by night, in health and in sickness, always — *always!*"

He was destined, however, to a few more years of activity, the reward, perhaps, of his patient and persistent struggle for recovery. After a winter of absolute seclusion, passed in his sick chamber, he was allowed by his physician, in the spring of 1870, to seek change at the quiet village of Deerfield on the Connecticut River. Nature proved the best physician. Unable when he arrived to take more than a few steps without vertigo, he could, before many weeks were over, walk several miles a day. Keen as an Egyptologist for the hieroglyphics of his science, he was soon deciphering the local inscriptions of the glacial period, tracking the course of the ice on slab and dike and river-bed, — on every natural surface. The old music sang again in his ear and wooed him back to life.

In the mean time, his assistants and students were doing all in their power to keep the work of the Museum at high-water mark. The publications, the classification and arrangement of the more recent collections, the distribution of such portions as were intended for the public, the system of exchanges, went on uninterruptedly. The working force at the Museum was, indeed, now very strong. In great degree it was, so to speak, home-bred.

Agassiz had gradually gathered about him, chiefly from among his more special students, a staff of assistants who were familiar with his plans and shared his enthusiasm. To these young friends he was warmly attached. It would be impossible to name them all, but the knot of younger men who were for years his daily associates in scientific work, whose sympathy and coöperation he so much valued, and who are now in their turn growing old in the service of science, will read the roll-call between the lines, and know that none are forgotten here. Years before his own death, he had the pleasure of seeing several of them called to important scientific positions, and it was a cogent evidence to him of the educational efficiency of the Museum, that it had supplied to the country so many trained investigators and teachers. Through them he himself teaches still. There was a prophecy in Lowell's memorial lines: —

> "He was a Teacher: why be grieved for him
> Whose living word still stimulates the air?
> In endless file shall loving scholars come,
> The glow of his transmitted touch to share."

Beside these, there were several older, experienced naturalists, who were permanently or transiently engaged at the Museum. Some

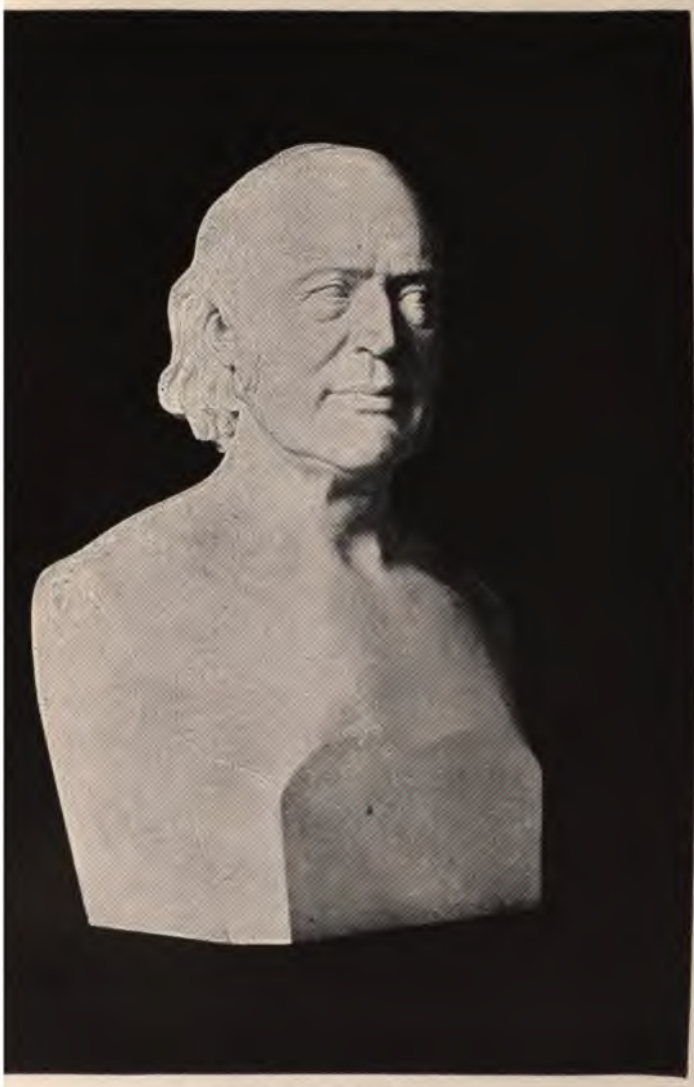
were heads of departments, while others lent assistance occasionally in special work. Again the list is too long for enumeration, but as the veteran among the older men Mr. J. G. Anthony should be remembered. Already a conchologist of forty years' standing when he came to the Museum in 1863, he devoted himself to the institution until the day of his death, twenty years later. Among those who came to give occasional help were Mr. Lesquereux, the head of paleontological botany in this country; M. Jules Marcou, the geologist; and M. de Pourtalès, under whose care the collection of corals was constantly improved and enlarged. The last named became at last wholly attached to the Museum, sharing its administration with Alexander Agassiz after his father's death.

To this band of workers some accessions had recently been made. More than two years before, Agassiz had been so fortunate as to secure the assistance of the entomologist, Dr. Hermann Hagen, from Königsberg, Prussia. He came at first only for a limited time, but he remained, and still remains, at the Museum, becoming more and more identified with the institution, beside filling a place as professor in Harvard University. His scientific

sympathy and support [illegible] value to Agassiz during [illegible] A later new-comer, and [illegible] at the Museum, was Dr. [illegible] of Vienna, who arrived [illegible] 1870 to put in final [illegible] Brazilian fishes, and [illegible] country. Thus Agassiz's [illegible] strengthened. Beside [illegible] the salaried assistants and [illegible] seum received much [illegible] the scientific volunteers [illegible] years François de Pourtalès [illegible] man, James M. Barnard, [illegible] assiz, while the business [illegible] tution were undertaken by [illegible] Agassiz's brother-in-law. [illegible] been of great service to the [illegible] lector on the Pacific coast [illegible] made this work his [illegible] hours of a merchant's [illegible]

Broken as he was in health [illegible] to see the amount of work [illegible] by Agassiz during this [illegible] of 1870. The letters written [illegible]

[1] For the history of the Museum [illegible] is made in the regular reports [illegible] tution.



BUST OF AGASSIZ

By Powers

time concerning the Museum alone would fill a good-sized volume. Such a correspondence is unfit for reproduction here, but its minuteness shows that almost the position of every specimen, and the daily, hourly work of every individual in the Museum, were known to him. The details of administration form, however, but a small part of the material of this correspondence. The consideration and discussion of the future of the Museum with those most nearly concerned, fill many of the letters. They give evidence of a fostering and far-reaching care, which provided for the growth and progress of the Museum, long after his own share in it should have ceased.

In reviewing Agassiz's scientific life in the United States, its brilliant successes, and the genial generous support which it received in this country, it is natural to give prominence to the brighter side. And yet it must not be forgotten that like all men whose ideals outrun the means of execution, he had moments of intense depression and discouragement. Some of his letters, written at this time to friends who controlled the financial policy of the Museum, are almost like a plea for life. While the trustees urge safe investments and the expenditure of income alone, he believes that in

proportion to the growth and expansion of the Museum will be its power of self-maintenance and its claim on the community at large. In short, expenditure seemed to him the best investment, insuring a fair return, on the principle that the efficiency and usefulness of an institution will always be the measure of the support extended to it. The two or three following letters, in answer to letters from Agassiz which cannot be found, show how earnestly, in spite of physical depression, he strove to keep the Museum in relation with foreign institutions, to strengthen the former, and coöperate as far as possible with the latter.

FROM PROFESSOR VON SIEBOLD.

MUNICH, 1869.

. . . Most gladly shall I meet your wishes both with regard to the fresh-water fishes of Central Europe and to your desire for the means of direct comparison between the fishes brought by Spix from Brazil and described by you, and those you have recently yourself collected in the Amazons. The former, with one exception, are still in existence and remain undisturbed, for since your day no one has cared to work at the fishes or reptiles. Schubert took no interest in the zoölogical cabinet

intrusted to him; and Wagner, who later relieved him of its management, cared chiefly for the mammals. I have now, however, given particular attention to the preservation of everything determined by you, so far as it could be found, and am truly glad that this material is again to be called into the service of science. Of course I had to ask permission of the "General Conservatorium of Scientific Collections" before sending this property of the state on so long a journey. At my urgent request this permission was very cordially granted by Herr von Liebig, especially as our collection is likely to be increased by the new forms you offer us.

As to the fresh-water fishes I must beg for a little time. At the fish market, in April or May, I can find those Cyprinoids, the males of which bear at the spawning season that characteristic eruption of the skin, which has so often and so incorrectly led to the making of new species. . . .

From your son Alexander I receive one beautiful work after another. Give him my best thanks for these admirable gifts, which I enter with sincere pleasure in my catalogue of books. You are indeed happy to have such a co-worker at your side. At the next oppor-

tunity I shall write my thanks to him personally.

How is Dr. Hermann Hagen pleased with his new position? I think the presence of this superior entomologist will exert a powerful and important influence upon the development of entomology in North America. . . .

FROM PROFESSOR G. P. DESHAYES.

MUSEUM OF NATURAL HISTORY,
PARIS, *February* 4, 1870.

Your letter was truly an event, my dear friend, not only for me but for our Museum. . . . How happy you are, and how enviable has been your scientific career, since you have had your home in free America! The founder of a magnificent institution, to which your glorious name will forever remain attached, you have the means of carrying out whatever undertaking commends itself to you as useful. Men and things, following the current that sets toward you, are drawn to your side. You desire, and you see your desires carried out. You are the sovereign leader of the scientific movement around you, of which you yourself have been the first promoter.

What would our old Museum not have gained in having at its head a man like you!

We should not now be lying stagnant in a space so insufficient that our buildings, by the mere force of circumstances, are transformed into store-houses, where objects of study are heaped together, and can be of no use to any one. . . . You can fancy how much I envy your organization. It depressed me to read your letter, with its brilliant proposals of exchange, remembering how powerless we are to meet even a small number of them. Your project is certainly an admirable one; to find the scientific nomenclature where it is best established, and by the help of good specimens transport it to your own doors. Nothing could be better, and I would gladly assist in it. But to succeed in this excellent enterprise one must have good duplicate specimens; not having them, one must have money. As a conclusion to your letter, the question of money was brought before my assembled colleagues, but the answer was vague and uncertain. I must, then, find resources in some other way, and this is what I propose to do. . . . [Here follow some plans for exchange.] Beside this, I will busy myself in getting together authentic collections from our French seas, both Oceanic and Mediterranean, and even from other points in the European seas.

Meantime, you shall have your share henceforth in whatever comes to me. . . . I learn from your son that your health is seriously attacked. I was grieved to hear it. Take care of yourself, my dear friend. You are still needed in this world; you have a great work to accomplish, the end and aim of which you alone are able to reach. You must, therefore, still stand in the breach for some years to come.

Your letter, which shows me the countless riches you have to offer at the Museum, puts me in the frame of mind of the child who was offered his choice in a toy-shop. "I choose everything," he said. I could reply in the same way. I choose all you offer me. Still, one must be reasonable, and I will therefore name, as the thing I chiefly desire, the remarkable fauna dredged from the Gulf Stream. Let me add, however, in order to give you entire freedom, that whatever you may send to the Museum will be received with sincere and ardent gratitude.

And so, farewell, my dear friend, with a warm shake of the hand and the most cordial regard. DESHAYES.

The next is in answer to a letter from

Agassiz to the veteran naturalist, Professor Sedgwick, concerning casts of well-known fossil specimens in Cambridge, England. Though the casts were unattainable, the affectionate reply gave Agassiz keen pleasure.

FROM PROFESSOR ADAM SEDGWICK.

THE CLOSE, NORWICH, *August* 9, 1871.

MY VERY DEAR AND HONORED FRIEND, — . . . I of course showed your letter to my friend Seeley, and after some consultation with men of practical knowledge, it was considered almost impossible to obtain such casts of the reptilian bones as you mention. The specimens of the bones are generally so rugged and broken, that the artists would find it extremely difficult to make casts from them without the risk of damaging them, and the authorities of the university, who are the proprietors of the whole collection in my Museum, would be unwilling to encounter that risk. Mr. Seeley, however, fully intends to send you a gutta-percha cast of the cerebral cavity of one of our important specimens described in "Seeley's Catalogue," but he is full of engagements and may not hitherto have realized his intentions. As for myself, at present I can do nothing except hobble daily on my stick from my house

to the Cathedral, for I am afflicted by a painful lameness in my left knee. The load of years begins to press upon me (I am now toiling through my 87th year), and my sight is both dim and irritable, so that, as a matter of necessity, I am generally compelled to employ an amanuensis. That part is now filled by a niece who is to me in the place of a dear daughter.

I need not tell you that the meetings of the British Association are still continued, and the last session (this year at Edinburgh) only ended yesterday. Let me correct a mistake. I met you first at Edinburgh in 1834, the year I became Canon, and again at Dublin in 1835. . . . It is a great pleasure to me, my dear friend, to see again by the vision of memory that fine youthful person, that benevolent face, and to hear again, as it were, the cheerful ring of the sweet and powerful voice by which you made the old Scotchmen start and stare, while you were bringing to life again the fishes of their old red sandstone. I must be content with the visions of memory and the feelings they again kindle in my heart, for it will never be my happiness to see your face again in this world. But let me, as a Christian man, hope that we may meet hereafter in

heaven, and see such visions of God's glory in the moral and material universe, as shall reduce to a mere germ everything which has been elaborated by the skill of man, or revealed to God's creatures. I send you an old man's blessing, and remain,

Your affectionate friend,

ADAM SEDGWICK.

In November, 1870, Agassiz was able to return to Cambridge and the Museum, and even to resume his lectures, which were as vigorous and fresh as ever. So entirely did he seem to have recovered, that in the course of the winter the following proposition was made to him by his friend, Professor Benjamin Peirce, then Superintendent of the Coast Survey.

FROM PROFESSOR PEIRCE.

COAST SURVEY OFFICE, WASHINGTON, *February* 18, 1871.

. . . I met Sumner in the Senate the day before yesterday, and he expressed immense delight at a letter he had received from Brown-Séquard, telling him that you were altogether free from disease. . . . Now, my dear friend, I have a very serious proposition for you. I am going to send a new iron sur-

veying steamer round to California in the course of the summer. She will probably start at the end of June. Would you go in her, and do deep-sea dredging all the way round? If so, what companions will you take? If not, who shall go? . . .

FROM AGASSIZ TO PROFESSOR PEIRCE.

CAMBRIDGE, *February* 20, 1871.

. . . I am everjoyed at the prospect your letter opens before me. Of course I will go, unless Brown-Séquard orders me positively to stay on terra firma. But even then, I should like to have a hand in arranging the party, as I feel there never was, and is not likely soon again to be, such an opportunity for promoting the cause of science generally, and that of natural history in particular. I would like Pourtalès and Alex. to be of the party, and both would gladly join if they can. Both are as much interested about it as I am, and I have no doubt between us we may organize a working team, strong enough to do something creditable. It seems to me that the best plan to pursue in the survey would be to select carefully a few points (as many as time would allow) on shore, from which to work at right angles with the coast, to as great a distance as

the results would justify, and then move on to some other head-land. If this plan be adopted, it would be desirable to have one additional observer to make collections on shore, to connect with the result of the dredgings. This would be the more important as, with the exception of Brazil, hardly anything is known of the shore faunæ upon the greater part of the South American coast. For shore observations, I should like a man of the calibre of Dr. Steindachner, who has spent a year on the coast of Senegal, and would thus bring a knowledge of the opposite side of the Atlantic as a starting basis of comparison. . . .

After consultation with his physicians, it was decided that Agassiz might safely undertake the voyage in the Hassler, that it might indeed be of benefit to his health. His party of naturalists, as finally made up, consisted of Agassiz himself, Count de Pourtalès, Dr. Franz Steindachner, and Mr. Blake, a young student from the Museum, who accompanied Agassiz as assistant and draughtsman. Dr. Thomas Hill, ex-president of Harvard University, was also on the expedition, and though engaged in special investigations of his own, he joined in all the work with genial interest.

The vessel was commanded by Captain (now Commodore) Philip C. Johnson, whose courtesy and kindness made the Hassler a floating home to the guests on board. So earnest and active was the sympathy felt by him and his officers in the scientific interests of the expedition, that they might be counted as a valuable additional volunteer corps. Among them should be counted Dr. William White, of Philadelphia, who accompanied the expedition in a partly professional, partly scientific capacity.

The hopes Agassiz had formed of this expedition, as high as those of any young explorer, were only partially fulfilled. His enthusiasm, though it had the ardor of youth, had none of its vagueness. In a letter to Mr. Peirce, published in the Museum Bulletin at this time, there is this passage: "If this world of ours is the work of intelligence and not merely the product of force and matter, the human mind, as a part of the whole, should so chime with it, that from what is known it may reach the unknown. If this be so, the knowledge gathered should, within the limits of error which its imperfection renders unavoidable, enable us to foretell what we are likely to find in the deepest abysses of the sea." He looked, in short, for the solution of special

problems directly connected with all his previous work. He believed the deeper sea would show forms of life akin to animals of earlier geological times, throwing new light on the relation between the fossil and the living world. In the letter above quoted, he even named the species he expected to find most prevalent in those greater depths: as, for instance, representatives of the older forms of Ganoids and Selachians; Cephalopods, resembling the more ancient chambered shells; Gasteropods, recalling the tertiary and cretaceous types; and Acephala, resembling those of the jurassic and cretaceous formations. He expected to find Crustaceans also, more nearly approaching the ancient Trilobites than those now living on the surface of the globe; and among Radiates he looked for the older forms of sea-urchins, star-fishes, and corals. Although the collections brought together on this cruise were rich and interesting, they gave but imperfect answers to these comprehensive questions. Owing to defects in the dredging apparatus, the hauls from the greatest depths were lost.

With reference to the glacial period he anticipated still more positive results. In the same letter the following passage occurs:

"There is, however, still one kind of evidence wanting, to remove all doubt that the greater extension of glaciers in former ages was connected with cosmic changes in the physical condition of our globe. Namely, all the phenomena relating to the glacial period must be found in the southern hemisphere, accompanied by the same characteristic features as in the north, but with this essential difference, — that everything must be reversed. The trend of the glacial abrasions must be from the south northward, the lee-side of abraded rocks must be on the north side of the hills and mountain ranges, and the boulders must have traveled from the south to their present position. Whether this be so or not, has not yet been ascertained by direct observation. I expect to find it so throughout the temperate and cold zones of the southern hemisphere, with the exception of the present glaciers of Terra del Fuego and Patagonia, which may have transported boulders in every direction. Even in Europe, geologists have not yet sufficiently discriminated between local glaciers and the phenomena connected with their different degrees of successive retreat on the one hand; and, on the other, the facts indicating the action of an extensive sheet of ice moving

over the whole continent from north to south. Among the facts already known from the southern hemisphere are the so-called rivers of stone in the Falkland Islands, which attracted the attention of Darwin during his cruise with Captain Fitzroy, and which have remained an enigma to this day. I believe it will not be difficult to explain their origin in the light of the glacial theory, and I fancy they may turn out to be ground moraines similar to the 'horsebacks' in Maine.

"You may ask what this question of drift has to do with deep-sea dredging? The connection is closer than may at first appear. If drift is not of glacial origin, but is the product of marine currents, its formation at once becomes a matter for the Coast Survey to investigate. But I believe it will be found in the end, that so far from being accumulated by the sea, the drift of the Patagonian lowlands has been worn away by the sea to its present outline, like the northern shores of South America and Brazil." . . .

This is not the place for a detailed account of the voyage of the Hassler, but enough may be told to show something of Agassiz's own share in it. A journal of scientific and personal experience, kept by Mrs. Agassiz under

his direction, was nearly ready for publication at the time of his death. The two next chapters, devoted to the cruise of the Hassler, are taken from that manuscript. A portion of it appeared many years ago in the pages of the "Atlantic Monthly."

CHAPTER XXIII.

1871–1872 : ÆT. 64–65.

Sailing of the Hassler. — Sargassum Fields. — Dredging at Barbadoes. — From the West Indies to Rio de Janeiro. — Monte Video. — Quarantine. — Glacial Traces in the Bay of Monte Video. — The Gulf of Mathias. — Dredging off Gulf of St. George. — Dredging off Cape Virgens. — Possession Bay. — Salt Pool. — Moraine. — Sandy Point. — Cruise through the Straits. — Scenery. — Wind Storm. — Borja Bay. — Glacier Bay. — Visit to the Glacier. — Chorocua Bay.

THE vessel was to have started in August, but, owing to various delays in her completion, she was not ready for sea until the late autumn. She finally sailed on December 4, 1871, on a gray afternoon, which ushered in the first snow-storm of the New England winter. Bound for warmer skies, she was, however, soon in the waters of the Gulf Stream, where the work of collecting began in the fields of Sargassum, those drifting, wide-spread expanses of loose sea-weed carrying a countless population, lilliputian in size, to be sure, but very various in character. Agassiz was no

less interested than other naturalists have been in the old question so long asked and still unanswered, about the Sargassum. "Where is its home, and what its origin? Does it float, a rootless wanderer on the deep, or has it broken away from some submarine attachment?" He had passed through the same region before, in going to Brazil, but then he was on a large ocean steamer, while from the little Hassler, of 360 tons, one could almost fish by hand from the Sargassum fields. Some of the chief results are given in the following letter.

TO PROFESSOR PEIRCE.

ST. THOMAS, *December* 15, 1871.

. . . As soon as we reached the Gulf Stream we began work. Indeed, Pourtalès had organized a party to study the temperatures as soon as we passed Gay Head, and will himself report to you his results. My own attention was entirely turned to the Gulf weed and its inhabitants, of which we made extensive collections. Our observations on the floating weed itself favor the view of those who believe it to be torn from rocks, on which Sargassum naturally grows. I made a simple experiment which seems to me conclusive. Any branch of the sea-weed which is deprived

of its *floats* sinks at once to the bottom of the water, and these floats are not likely to be the first parts developed from the spores. Moreover, after examining large quantities of the weed, I have not seen a single branch, however small, which did not show marks of having been torn from a solid attachment.

You may hardly feel an interest in my zoological observations, but I am sure you will be glad to learn that we had the best opportunity of carefully examining most of the animals known to inhabit the Gulf weed, and some also which I did not know to occur among them. The most interesting discovery of our voyage thus far, however, is that of a nest built by a fish, and floating on the broad ocean with its living freight. On the 13th, Mr. Mansfield, one of our officers, brought me a ball of Gulf weed which he had just picked up, and which excited my curiosity to the utmost. It was a round mass of Sargassum about the size of two fists. The bulk of the ball was made up of closely packed branches and leaves, held together by fine threads, running through them in every direction, while other branches hung more loosely from the margin. Placed in a large bowl of water it became apparent that the loose branches

served to keep the central mass floating, cradle-like, between them. The elastic threads, which held the ball of Gulf weed together, were beaded at intervals, sometimes two or three beads close together, or a bunch of them hanging from the same cluster of threads, or occasionally scattered at a greater distance from each other. Nowhere was there much regularity in the distribution of the beads. They were scattered pretty uniformly throughout the whole ball of sea-weed, and were themselves about the size of an ordinary pin's head. Evidently we had before us a nest of the most curious kind, full of eggs. What animal could have built this singular nest? It did not take long to ascertain the class to which it belonged. A common pocket lens revealed at once two large eyes on the side of the head, and a tail bent over the back of the body, as in the embryo of ordinary fishes shortly before the period of hatching. The many empty egg cases in the nest gave promise of an early opportunity of seeing some embryos, freeing themselves from their envelope. Meanwhile a number of these eggs containing live embryos were cut out of the nest and placed in separate glass jars, in order to multiply the chances of preserving them;

while the nest as a whole was secured in alcohol, as a memorial of our discovery.

The next day I found two embryos in my glass jars; they moved occasionally in jerks, and then rested a long time motionless on the bottom of the jar. On the third day I had over a dozen of these young fishes, the oldest beginning to be more active. I need not relate in detail the evidence I soon obtained that these embryos were actually fishes. . . . But what kind of fish was it? At about the time of hatching, the fins differ too much from those of the adult, and the general form has too few peculiarities, to give any clew to this problem. I could only suppose it would prove to be one of the pelagic species of the Atlantic. In former years I had made a careful study of the pigment cells of the skin in a variety of young fishes, and I now resorted to this method to identify my embryos. Happily we had on board several pelagic fishes alive. The very first comparison I made gave the desired result. The pigment cell of a young Chironectes pictus proved identical with those of our little embryos. It thus stands, as a well authenticated fact, that the common pelagic Chironectes of the Atlantic, named Ch. pictus by Cuvier, builds a nest for

its eggs in which the progeny is wrapped up with the materials of which the nest itself is composed; and as these materials consist of the living Gulf weed, the fish cradle, rocking upon the deep ocean, is carried along as in an arbor, which affords protection and afterwards food also, to its living freight. This marvelous story acquires additional interest, when we consider the characteristic peculiarities of the genus Chironectes. As its name indicates, it has fin-like hands; that is to say, the pectoral fins are supported by a kind of long wrist-like appendage, and the rays of the ventrals are not unlike rude fingers. With these limbs these fishes have long been known to attach themselves to sea-weeds, and rather to walk than to swim in their natural element. But now that we know their mode of reproduction, it may fairly be asked if the most important use of their peculiarly constructed fins is not the building of their nest? . . . There thus remains one closing chapter to the story. May some naturalist, becalmed among the Gulf weed, have the good fortune to witness the process by which the nest is built. . . .

This whole investigation was of the greatest interest to Agassiz, and, coming so early in

the voyage, seemed a pleasant promise of its farther opportunities. The whole ship's company soon shared his enthusiasm, and the very sailors gathered about him in the intervals of their work, or hung on the outskirts of the scientific circle. A pause of a few days was made at one or two of the West Indian islands, at St. Thomas and Barbadoes. At the latter, the first cast of the large dredge was made on a ledge of shoals in a depth of eighty fathoms, and, among countless other things, a number of stemmed crinoids and comatulæ were brought up. An ardent student of the early fossil echinoderms, it was a great pleasure to Agassiz to gather their fresh and living representatives. It was like turning a leaf of the past and finding the subtle thread which connects it with the present.

TO PROFESSOR PEIRCE.

PERNAMBUCO, *January* 16, 1872.

MY DEAR PEIRCE, — I should have written to you from Barbadoes, but the day before we left the island was favorable for dredging, and our success in that line was so unexpectedly great, that I could not get away from the specimens, and made the most of them for study while I had the chance. We made only four

hauls, in between seventy-five and one hundred and twenty fathoms. But what hauls! Enough to occupy half a dozen competent zoologists for a whole year, if the specimens could be kept fresh for that length of time. The first haul brought up a Chemidium-like sponge; the next gave us a crinoid, very much like the Rhizocrinus lofotensis, but probably different; the third, a living Pleurotomaria; the fourth, a new genus of Spatangoids, etc., etc., not to speak of the small fry. We had the crinoid alive for ten or twelve hours. When contracted, the pinnules are pressed against the arms, and the arms themselves shut against one another, so that the whole looks like a swash made up of a few long, coarse twines. When the animal opens, the arms at first separate without bending outside, so that the whole looks like an inverted pentapod; but gradually the tips of the arms bend outward as the arms diverge more and more, and when fully expanded the crown has the appearance of a lily of the L. martagon type, in which each petal is curved upon itself, the pinnules of the arms spreading laterally more and more, as the crown is more fully open. I have not been able to detect any motion in the stem traceable to contrac-

tion, though there is no stiffness in its bearing. When disturbed, the pinnules of the arms first contract, the arms straighten themselves out, and the whole gradually and slowly closes up. It was a very impressive sight for me to watch the movements of the creature, for it not only told of its own ways, but at the same time afforded a glimpse into the countless ages of the past, when these crinoids, so rare and so rarely seen nowadays, formed a prominent feature of the animal kingdom. I could see, without great effort of the imagination, the shoal of Lockport teeming with the many genera of crinoids which the geologists of New York have rescued from that prolific Silurian deposit, or recall the formations of my native country, in the hill-sides of which also, among fossils indicating shoal water deposits, other crinoids abound, resembling still more closely those we find in these waters. The close affinities of Rhizocrinus with Apiocrinoids are further exemplified by the fact that when the animal dies, it casts off its arms, like Apiocrinus, the head of which is generally found without arms. And now the question may be asked, what is the meaning of the occurrence of these animals in deep waters at the present day, when, in former

ages, similar types inhabited shallow seas? Of the fact there can be no doubt, for it is not difficult to adduce satisfactory evidence of the shoal-like character of the Silurian deposits of the State of New York; their horizontal position, combined with the gradual recession of the higher beds in a southerly direction, leaves no doubt upon this point; and in the case of the jurassic formation alluded to above, the combination of the crinoids with fossils common upon coral reefs, and their presence in atolls of that period, are satisfactory proofs of my assertion. What does it mean, then, when we find the Pentacrinus and Rhizocrinus of the West Indies in deep water only? It seems to me that there is but one explanation of the fact, namely, that in the progress of the earth's growth, we must look for such a displacement of the conditions favorable to the maintenance of certain lower types, as may recall most fully the adaptations of former ages. It was in this sense I alluded, in my first letter to you, to the probability of our finding in deeper water representatives of earlier geological types; and if my explanation is correct, my anticipation is also fully sustained. But do the deeper waters of the present constitution of our globe really ap-

proximate the conditions for the development of animal life, which existed in the shallower seas of past geological ages? I think they do, or at least I believe they approach it as nearly as anything can in the present order of things upon earth; for the depths of the ocean alone can place animals under a pressure corresponding to that caused by the heavy atmosphere of earlier periods. But, of course, such high pressure as animals meet in great depths cannot be a favorable condition for the development of life; hence the predominance of lower forms in the deep sea. The rapid diminution of light with the increasing depth, and the small amount of free oxygen in these waters under greater and greater pressure, not to speak of other limitations arising from the greater uniformity of the conditions of existence, the reduced amount and less variety of nutritive substances, etc., etc., are so many causes acting in the same direction and with similar results. For all these reasons, I have always expected to find that the animals living in great depths would prove to be of a standing, in the scale of structural complications, inferior to those found in shoal waters or near shore; and the correlation elsewhere pointed out between the standing of animals

and their order of succession in geological times (see "Essay on Classification") justifies another form of expression of these facts, namely, that in deeper waters we should expect to find representatives of earlier geological periods. There is in all this nothing which warrants the conclusion that any of the animals now living are lineal descendants of those of earlier ages; nor does their similarity to those of earlier periods justify the statement that the cretaceous formation is still extant. It would be just as true to nature to say that the tertiaries are continued in the tropics, on account of the similarity of the miocene mammalia to those of the torrid zone.

We have another case in the Pleurotomaria. It is not long since it has been made known that the genus Pleurotomaria is not altogether extinct, a single specimen having been discovered about ten years ago in the West Indies. Even Pictet, in the second edition of his Paleontology, still considers Pleurotomaria as extinct, and as belonging to the fossiliferous formations which extend from the Silurian period to the Tertiary. Of the living species found at Marie Galante, nothing is known except the specific characteristics of the shell. We dredged it in one hundred and twenty

fathoms, on the west side of Barbadoes, alive, and kept it alive for twenty-four hours, during which time the animal expanded and showed its remarkable peculiarities. It is unquestionably the type of a distinct family, entirely different from the other Mollusks with which it has been hitherto associated. Mr. Blake has made fine colored drawings of it, which may be published at some future time. . . . The family of the Pleurotomariæ numbers between four and five hundred fossil species, beginning in the Silurian deposits, but especially numerous in the carboniferous and jurassic formations.

The sponges afford another interesting case. When the first number of the great work of Goldfuss, on the fossils of Germany, made its appearance, about half a century ago, the most novel types it made known were several genera of sponges from the jurassic and cretaceous beds, described under the names of Siphonia, Chemidium, and Scyphia. Nothing of the kind has been known among the living to this day; and yet, the first haul of the dredge near Barbadoes gave us a Chemidium, or, at least, a sponge so much like the fossil Chemidium, that it must remain for future comparisons to determine whether there are

any generic differences between our living sponge and the fossil. The next day brought us a genuine Siphonia, another genus thus far only known from the jurassic beds; and it is worth recording, that I noticed in the collection of Governor Rawson another sponge, — brought to him by a fisherman who had caught it on his line, on the coast of Barbadoes, — which belongs to the genus Scyphia. Thus the three characteristic genera of sponges from the secondary formation, till now supposed to be extinct, are all three represented in the deep waters of the West Indies. . . .

Another family of organized beings offers a similar testimony to that already alluded to. If there is a type of Echinoderms characteristic of a geological period, it is the genus Micraster of the cretaceous formation, in its original circumscription. No species of this genus is known to have existed during the Tertiary era, and no living species has as yet been made known. You may therefore imagine my surprise when the dredge first yielded three specimens of a small species of that particular group of the genus, which is most extensively represented in the upper cretaceous beds.

Other examples of less importance might be

enumerated; suffice it now to add that my expectation of finding in deep waters animals already known, but thus far exceedingly rare in museums, is already in a measure realized. . . .

Little can be said of the voyage from the West Indies to Rio de Janeiro. It had the usual vicissitudes of weather, with here and there a flight (so it might justly be called) of flying-fish, a school of porpoises or dog-fish, or a sail in the distance, to break the monotony. At Rio de Janeiro it became evident that the plan of the voyage must be somewhat curtailed. This was made necessary partly by the delays in starting, — in consequence of which the season would be less favorable than had been anticipated along certain portions of the proposed route, — and partly by the defective machinery, which had already given some trouble to the Captain. The Falkland Islands, the Rio Negro, and the Santa Cruz rivers were therefore renounced; with what regret will be understood by those who know how hard it is to be forced to break up a scheme of work, which was originally connected in all its parts. The next pause was at Monte Video; but as there was a strict

quarantine, Agassiz was only allowed to land at the Mount, a hill on the western side of the bay, the geology of which he was anxious to examine. He found true erratics — loose pebbles, granite, gneiss, and granitic sandstone, having no resemblance to any native rock in the vicinity — scattered over the whole surface of the hill to its very summit. The hill itself had also the character of the "roches moutonnées" modeled by ice in the northern hemisphere. As these were the most northern erratics and glaciated surfaces reported in the southern hemisphere, the facts there were very interesting to him.

With dredgings off the Rio de la Plata, and along the coast between that and the Rio Negro, the vessel held on her way to the Gulf of Mathias, a deep, broad bay running some hundred miles inland, and situated a little south of the Rio Negro. Here some necessary repairs enforced a pause, of which Agassiz took advantage for dredging and for studying the geology of the cliffs along the north side of the bay. As seen from the vessel, they seemed to be stratified with extraordinary evenness and regularity to within a few feet of the top, the summit being crowned with loose sand. Farther on, they sank to sand

dunes piled into rounded banks and softly moulded ledges, like snow-drifts. Landing the next day at a bold bluff marked Cliff End on the charts, he found the lower stratum to consist of a solid mass of tertiary fossils, chiefly immense oysters, mingled, however, with sea-urchins. Superb specimens were secured, — large boulders crowded with colossal shells and perfectly preserved echini. From the top of the cliff, looking inland, only a level plain was seen, stretching as far as the eye could reach, broken by no undulations, and covered with low, scrubby growth. The seine was drawn on the beach, and yielded a good harvest for the fish collection. At evening the vessel anchored at the head of the bay, off the Port of San Antonio. The name would seem to imply some settlement; but a more lonely spot cannot be imagined. More than thirty years ago, Fitzroy had sailed up this bay, partially surveyed it, and marked this harbor on his chart. If any vessel has broken the loneliness of its waters since, no record of any such event has been kept. Of the presence of man, there was no sign. Yet the few days passed there were among the pleasantest of the voyage to Agassiz. The work of the dredge and seine was extremely successful, and the

rambles inland were geological excursions of great interest. Here he had the first sight of the guanaco of the Patagonian plains. The weather was fine, and at night-fall, to the golden light of sunset succeeded the fitful glow, over land and water, of the bonfires built by the sailors on the beach. Returning to the ship after dark, the various parties assembled in the wardroom, to talk over the events of the day and lay out plans for the morrow. These are the brightest hours in such a voyage, when the novelty of the locality gives a zest to every walk or row, and all are full of interest in a new and exciting life. One is more tolerant even of monotonous natural features in a country so isolated, so withdrawn from human life and occupation. The very barrenness seems in harmony with the intense solitude.

The Hassler left her anchorage on this desolate shore on an evening of singular beauty. It was difficult to tell when she was on her way, so quietly did she move through the glassy waters, over which the sun went down in burnished gold, leaving the sky without a cloud. The light of the beach fires followed her till they too faded, and only the phosphorescence of the sea attended her into the

night. Rough and stormy weather followed this fair start, and only two more dredgings were possible before reaching the Strait of Magellan. One was off the Gulf of St. George, where gigantic star-fishes seemed to have their home. One of them, a superb basket-fish, was not less than a foot and a half in diameter; and another, like a huge sunflower of reddish purple tint, with straight arms, thirty-seven in number, radiating from the disk, was of about the same size. Many beautiful little sea-urchins came up in the same dredging. About fifty miles north of Cape Virgens, in tolerably calm weather, another haul was tried, and this time the dredge returned literally solid with Ophiurans.

On Wednesday, March 13th, on a beautifully clear morning, like the best October weather in New England, the Hassler rounded Cape Virgens and entered the Strait of Magellan. The tide was just on the flood, and all the conditions favorable for her run to her first anchorage in the Strait at Possession Bay. Here the working force divided, to form two shore parties, one of which, under Agassiz's direction, the reader may follow. The land above the first shore bluff at Possession Bay rises to a height of some four hundred

feet above the sea-level, in a succession of regular horizontal terraces, of which Agassiz counted eight. On these terraces, all of which are built, like the shore-bluffs, of tertiary deposits, were two curious remnants of a past state of things. The first was a salt-pool lying in a depression on the second terrace, some one hundred and fifty feet above the sea. This pool contained living marine shells, identical with those now found along the shore. Among them were Fusus, Mytilus, Buccinum, Fissurella, Patella, and Voluta, all found in the same numeric relations as those in which they now exist upon the beach below. This pool is altogether too high to be reached by any tidal influence, and undoubtedly indicates an old sea-level, and a comparatively recent upheaval of the shore. The second was a genuine moraine, corresponding in every respect to those which occur all over the northern hemisphere. Agassiz came upon it in ascending to the third terrace above the salt-pool and a little farther inland. It had all the character of a terminal moraine in contact with an actual glacier. It was composed of heterogeneous materials, — large and small pebbles and boulders impacted together in a paste of clayey gravel and sand. The ice had evi-

dently advanced from the south, for the mass had been pushed steeply up on the southern side, and retained so sharp an inclination on that face that but little vegetation had accumulated upon it. The northern side, on the contrary, was covered with soil and overgrown; it sloped gently off, — pebbles and larger stones being scattered beyond it. The pebbles and boulders of this moraine were polished, scratched, and grooved, and bore, in short, all the usual marks of glacial action. Agassiz was naturally delighted with this discovery. It was a new link in the chain of evidence, showing that the drift phenomena are connected at the south as well as at the north with the action of ice, and that the frozen Arctic and Antarctic fields are but remnants of a sheet of ice, which has retreated from the temperate zones of both hemispheres to the polar regions. The party pushed on beyond the moraine to a hill of considerable height, which gave a fine view of the country toward Mount Aymon and the so-called Asses' Ears. They brought back a variety of game, but their most interesting scientific acquisitions were boulders from the moraine scored with glacial characters, and shells from the salt-pool.

Still accompanied by beautiful weather, the Hassler anchored at the Elizabeth Islands and at San Magdalena. Here Agassiz had an opportunity of examining the haunts and rookeries of the penguins and cormorants, and obtaining fine specimens of both. As the breeding places and the modes of life of these animals have been described by other travelers, there is nothing new to add from his impressions, until the vessel anchored, on the 16th March, before Sandy Point, the only permanent settlement in the Strait.

Here there was a pause of several days, which gave Agassiz an opportunity to draw the seine with large results for his marine collections. By the courtesy of the Governor, he had also an opportunity of making an excursion along the road leading to the coal-mines. The wooded cliffs, as one ascends the hills toward the mines, are often bold and picturesque, and Agassiz found that portions of them were completely built of fossil shells. There is an oyster-bank, some one hundred feet high, overhanging the road in massive ledges that consist wholly of oyster-valves, with only earth enough to bind them together. He was inclined, from the character of the shells, to believe that the coal must be cretaceous rather than tertiary.

On Tuesday, the 19th March, the Hassler left Sandy Point. The weather was beautiful, — a mellow autumn day with a reminiscence of summer in its genial warmth. The cleft summit of Sarmiento was clear against the sky, and the snow-fields, swept over by alternate light and shadow, seemed full of soft undulations. The evening anchorage was in the Bay of Port Famine, a name which marks the site of Sarmiento's ill-fated colony, and recalls the story of the men who watched and waited there for the help that never came. The stay here was short, and Agassiz spent the time almost wholly in studying the singularly regular, but completely upturned strata which line the beach, with edges so worn down as to be almost completely even with each other.

For many days after this, the Hassler pursued her course, past a seemingly endless panorama of mountains and forests rising into the pale regions of snow and ice, where lay glaciers in which every rift and crevasse, as well as the many cascades flowing down to join the waters beneath, could be counted as she steamed by them. Every night she anchored in the sheltered harbors formed by the inlets and fiords which break the base of the

rocky walls, and often lead into narrower ocean defiles penetrating, one knows not whither, into the deeper heart of these great mountain masses.

These were weeks of exquisite delight to Agassiz. The vessel often skirted the shore so closely that its geology could be studied from the deck. The rounded shoulders of the mountains, in marked contrast to their peaked and jagged crests, the general character of the snow-fields and glaciers, not crowded into narrow valleys as in Switzerland, but spread out on the open slopes of the loftier ranges, or, dome like, capping their summits, — all this afforded data for comparison with his past experience, and with the knowledge he had accumulated upon like phenomena in other regions. Here, as in the Alps, the abrupt line, where the rounded and worn surfaces of the mountains (moutonnées, as the Swiss say) yield to their sharply cut, jagged crests, showed him the ancient and highest line reached by the glacial action. The long, serrated edge of Mount Tarn, for instance, is like a gigantic saw, while the lower shoulders of the mass are hummocked into a succession of rounded hills. In like manner the two beautiful valleys, separated by a bold bluff

called Bachelor's Peak, are symmetrically rounded on their slopes, while their summits are jagged and rough.

On one occasion the Hassler encountered one of those sudden and startling flaws of wind common to the Strait. The breeze, which had been strong all day, increased with sudden fury just as the vessel was passing through a rather narrow channel, which gave the wind the additional force of compression. In an inconceivably short time, the channel was lashed into a white foam; the roar of wind and water was so great you could not hear yourself speak, though the hoarse shout of command and the answering cry of the sailors rose above the storm. To add to the confusion, a loose sail slatted as if it would tear itself in pieces, with that sharp, angry, rending sound which only a broad spread of loose canvas can make. It became impossible to hold the vessel against the amazing power of the blast, and the Captain turned her round with the intention of putting her into Borja Bay, not far from which, by good fortune, she chanced to be. As she came broadside to the wind in turning, it seemed as if she must be blown over, so violently did she careen. Once safely round, she flew before the

wind, which now became her ally instead of her enemy, and by its aid she was soon abreast of Borja Bay. Never was there a more sudden transition from chaos to peace than that which ensued as she turned in from the tumult in the main channel to the quiet waters of the bay. The Hassler almost filled the tiny harbor shut in between mountains. She lay there safe and sheltered in breathless calm, while the storm raged and howled outside. These frequent, almost land-locked coves, are the safety of navigators in these straits; but after this day's experience, it was easy to understand how sailing vessels may be kept waiting for months between two such harbors, struggling vainly to make a few miles and constantly driven back by sudden squalls.

In this exquisite mountain-locked harbor, the vessel was weather-bound for a couple of days. Count Pourtalès availed himself of this opportunity to ascend one of the summits. Up to a height of fifteen hundred feet, the rock was characterized by the smoothed, rounded surfaces which Agassiz had observed along his whole route in the Strait. Above that height all was broken and rugged, the line of separation being as defined as on any valley wall in Switzerland. It was again im-

possible to decide, on such short observation, whether these effects were due to local glacial action, or whether they belonged to an earlier general ice-period. But Agassiz became satisfied, as he advanced, that the two sets of phenomena existed together, as in the northern hemisphere. The general aspect of the opposite walls of the Strait confirmed him in the idea that the sheet of ice in its former extension had advanced from south to north, grinding its way against and over the southern wall to the plains beyond. In short, he was convinced that, as a sheet of ice has covered the northern portion of the globe, so a sheet of ice has covered also the southern portion, advancing, in both instances, far toward the equatorial regions. His observations in Europe, in North America, and in Brazil seemed here to have their closing chapter.

With these facts in his mind, he did not fail to pause before Glacier Bay, noted for its immense glacier, which seems, as seen from the main channel, to plunge sheer down into the waters of the bay. A boat party was soon formed to accompany him to the glacier. It proved less easy of access than it looked at a distance. A broad belt of wood, growing, as Agassiz afterward found, on an accumula-

tion of old terminal moraines, spanned the lower valley from side to side. Through this wood there poured a glacial river, emptying itself into the bay. Strange to say, this glacier-washed forest, touching the ice on one side and the sea on the other, was full of flowers. The red bells of the glossy leaved Desfontainia, the lovely pink blossoms of the Phylesia, the crimson berries of the Pennetia, stood out in bright relief from a background of mossy tree-trunks and rocks. After an hour's walking, made laborious by the spongy character of the ground, — a mixture of loose soil and decaying vegetation, in which one sank knee-deep, — the gleam of the ice began to shimmer through the trees; and issuing from the wood, the party found themselves in front of a glacier wall, stretching across the whole valley and broken into deep rifts, caves, and crevasses of dark blue ice. The glacier was actually about a mile wide; but as the central portion was pressed forward in advance of the sides, the whole front was not presented at once. It formed a sharp crescent, with the curve turned outward. One of the caves in this front wall was some thirty or forty feet high, about a hundred feet deep, and two or three yards wide at the entrance. At the

further end it narrowed to a mere gallery, where the roof was pierced by a circular window, quite symmetrical in shape, through which one looked up to the blue sky and drifting clouds. There must be strange effects in this ice-cavern, when the sun is high and sends a shaft of light through its one window to illuminate the interior.

This first excursion was a mere reconnaissance. An approximate idea of the dimensions of the glacier, and some details of its structure, were obtained on a second visit the following day. The anchorage for the night was in Playa Parda Cove, one of the most beautiful of the many beautiful harbors of the Magellan Strait. It is entered by a deep, narrow slit, cut into the mountains on the northern side of the Strait, and widening at its farther end into a kind of pocket or basin, hemmed in between rocky walls bordered by forests, and overhung by snow and ice-fields. The next morning at half-past three o'clock, just as moonlight was fading before the dawn, and the mountains were touched with the coming day, the reveillé was sounded for those who were to return to Glacier Bay. This time Agassiz divided his force so that they could act independently of each other,

though under a general plan laid out by him. M. de Pourtalès and Dr. Steinhachner ascended the mountain to the left of the valley, following its ridge, in the hope of reaching a position from which they could discover the source and the full length of the glacier. In this they did not succeed, though M. de Pourtalès estimated its length, as far as he could see from any one point, to be about three miles, beyond which it was lost in the higher range. It made part of a net-work of glaciers running back into a large massif of mountains, and fed by many a névé on their upper slopes. The depth as well as the length of this glacier remains somewhat problematical, and indeed all the estimates in so cursory a survey must be considered as approximations rather than positive results. The glazed surface of the ice is an impediment to any examination from the upper side. It would be impossible to spring from brink to brink of a crevasse, as is so constantly done by explorers of Alpine glaciers where the edges of the cracks are often snowy or granular. Here the edges of the crevasses are sharp and hard, and to spring across one of any size would be almost certain death. There is no hold for an Alpine stock, no grappling point for hands

or feet. Any investigation from the upper surface would, therefore, require special apparatus, and much more time than Agassiz and his party could give. Neither was an approach from the side very easy. The glacier arches so much in the centre, and slopes away so steeply, that when one is in the lateral depression between it and the mountain, one faces an almost perpendicular wall of ice, which blocks the vision completely. M. de Pourtalès measured one of the crevasses in this wall, and found that it had a depth of some seventy feet. Judging from the remarkable convexity of the glacier, it can hardly be less in the centre than two or three times its thickness on the edges, — something over two hundred feet, therefore. Probably none of these glaciers of the Strait of Magellan are as thick as those of Switzerland, though they are often much broader. The mountains are not so high, the valleys not so deep, as in the Alps; the ice is consequently not packed into such confined troughs. By some of the party an attempt was made to ascertain the rate of movement, signals having been adjusted the day before for its measurement. During the middle of the day, it advanced at the rate of ten inches and a fraction

in five hours. One such isolated observation is of course of little comparative value. For himself, Agassiz reserved the study of the bay, the ancient bed of the glacier in its former extension. He spent the day in cruising about the bay in the steam-launch, landing at every point he wished to investigate. His first care was to examine minutely the valley walls over which the glacier must once have moved. Every characteristic feature, known in the Alps as the work of the glaciers, was not only easily recognizable here, but as perfectly preserved as anywhere in Switzerland. The rounded knolls to which De Saussure first gave the name of *roches moutonnées* were smoothed, polished, scratched, and grooved in the direction of the ice movement, the marks running mostly from south to north, or nearly so. The general trend of the scratches and furrows showed them to have been continuous from one knoll to another. The furrows were of various dimensions, sometimes shallow and several inches broad, sometimes narrow with more defined limits, gradually passing into mere lines on a very smoothly-polished surface. Even the curious notches scooped out of the even surfaces, and technically called "coups de gouge," were not

wanting. In some places the seams of harder rock stood out for a quarter of an inch or so above adjoining decomposed surfaces; in such instances the dike alone retained the glacial marks, which had been worn away from the softer rock.

The old moraines were numerous and admirably well preserved. Agassiz examined with especial care one colossal lateral moraine, standing about two miles below the present terminus of the ice and five hundred feet above the sea-level. It consisted of the same rocks as those found on the present terminal moraine, part of them being rounded and worn, while large, angular boulders rested above the smaller materials. This moraine forms a dam across a trough in the valley wall, and holds back the waters of a beautiful lake, about a thousand feet in length and five hundred in width, shutting it in just as the Lake of Méril in Switzerland is held in its basin by the glacier of Aletsch. There are erratics some two or three hundred feet above this great moraine, showing that the glacier must have been more than five hundred feet thick when it left this accumulation of loose materials at such a height. It then united, however, with a large glacier more to the

west. Its greatest thickness, as an independent glacier, is no doubt marked, not by the boulders lying higher up, but by the large moraine which shuts in the lake. The direct connection of this moraine with the glacier in its former extension is still further shown by two other moraines, on lower levels and less perfect, but having the same relation to the present terminus of the ice. The lower of these is only one hundred and fifty feet above the actual level of the glacier. These three moraines occur on the western slope of the bay. The eastern slope is more broken, and while the rounded knolls are quite as distinct and characteristic, the erratics are more loosely scattered over the surface. In mineralogical character they agree with those on the western wall of the bay. Upon the summits of some small islands at the entrance of the bay, there are also some remnants of terminal moraines, formed by the glacier when it reached the main channel; that is, when it was some three miles longer than now.

The more recent oscillations, marking the advance and retreat of the glacier within certain limits, are shown by the successive moraines heaped up in advance of the present terminal wall. The central motion here, as in

all the Swiss glaciers, is greater than the lateral, the ice being pushed forward in the middle faster than on the sides. But there would seem to be more than one axis of progression in this broad mass of ice; for though the centre is pushed out beyond the rest, the terminal wall does not present one uniform curve, but forms a number of more or less projecting angles or folds. A few feet in front of this wall is a ridge of loose materials, stones, pebbles, and boulders, repeating exactly the outline of the ice where it now stands; a few feet in advance of this, again, is another ridge precisely like it; still a few feet beyond, another; and so on, for four or five concentric zigzag crescent-shaped moraines, followed by two others more or less marked, till they fade into the larger morainic mass, upon which stands the belt of wood dividing the present glacier from the bay. Agassiz counted eight distinct moraines between the glacier and the belt of wood, and four concentric moraines in the wood itself. It is plain that the glacier has ploughed into the forest within some not very remote period, for the trees along its margin are loosened and half uprooted, though not yet altogether decayed. In the presence of the glacier

one ceases to wonder at the effects produced by so powerful an agent. This sheet of ice, even in its present reduced extent, is about a mile in width, several miles in length, and at least two hundred feet in depth. Moving forward as it does ceaselessly, and armed below with a gigantic file, consisting of stones, pebbles, and gravel, firmly set in the ice, who can wonder that it should grind, furrow, round, and polish the surfaces over which it slowly drags its huge weight. At once destroyer and fertilizer, it uproots and blights hundreds of trees in its progress, yet feeds a forest at its feet with countless streams; it grinds the rocks to powder in its merciless mill, and then sends them down, a fructifying soil, to the wooded shore below.

Agassiz would gladly have stayed longer in the neighborhood of Glacier Bay, and have made it the central point of a more detailed examination of the glacial phenomena in the Strait. But the southern winter was opening, and already gave signs of its approach. At dawn on the 26th of March, therefore, the Hassler left her beautiful anchorage in Playa Parda Cove, six large glaciers being in sight from her deck as she came out. The scenery during the morning had a new scientific in-

terest for Agassiz, because the vessel kept along the northern side of the Strait, while the course hitherto had been nearer the southern shore. He could thus better compare the differences between the two walls of the Strait. The fact that the northern wall is more evenly worn, more rounded than the southern, had a special significance for him, as corresponding with like facts in Switzerland, and showing that the ice-sheet had advanced across the Strait with greater force in its ascending than in its descending path. The north side being the strike side, the ice would have pushed against it with greater force. Such a difference between the two sides of any hollow or depression in the direct path of the ice is well known in Switzerland.

Later in the day, a pause was made in Chorocua Bay, where Captain Mayne's chart makes mention of a glacier descending into the water. There is, indeed, a large glacier on its western side, but so inaccessible, that any examination of it would have required days rather than hours. No one, however, regretted the afternoon spent here, for the bay was singularly beautiful. On either side, deep gorges, bordered by richly-wooded cliffs and overhung by ice and snow-fields, were cut into

the mountains. Where these channels might lead, into what dim recesses of ocean and mountain, could only be conjectured. The bay, with all its inlets and fiords, was still as a church. Voices and laughter seemed an intrusion, and a louder shout came back in echoes from far-off hidden retreats. Only the swift steamer-ducks, as they shot across, broke the glassy surface of the water with their arrow-like wake. From this point the Hassler crossed to Sholl Bay, and anchored at the entrance of Smythe's Channel. As sunset faded over the snow mountains opposite her anchorage, their white reflection lay like marble in the water.

CHAPTER XXIV.

1872 : ÆT. 65.

Picnic in Sholl Bay. — Fuegians. — Smythe's Channel. — Comparison of Glacial Features with those of the Strait of Magellan. — Ancud. — Port of San Pedro. — Bay of Concepcion. — Three Weeks in Talcahuana. — Collections. — Geology. — Land Journey to Santiago. — Scenes along the Road. — Report on Glacial Features to Mr. Peirce. — Arrival at Santiago. — Election as Foreign Associate of the Institute of France. — Valparaiso. — The Galapagos. — Geological and Zoölogical Features. — Arrival at San Francisco.

THE next day forces were divided. The vessel put out into the Strait again for sounding and dredging, while Agassiz, with a smaller party, landed in Sholl Bay. Here, after having made a fire and pitched a tent in which to deposit wraps, provisions etc., the company dispersed in various directions along the shore, geologizing, botanizing, and collecting. Agassiz was especially engaged in studying the structure of the beach itself. He found that the ridge of the beach was formed by a glacial moraine, while accumulations of boulders, banked up in morainic ridges, concentric with

one another and with the beach moraine, extended far out from the shore like partly sunken reefs. The pebbles and boulders of these ridges were not local, or, at least, only partially so; they had the same geological character as those of the drift material throughout the Strait.

The day was favorable for work, and there was little to remind one of approaching winter. A creek of fresh water, that ran out upon one part of the beach, led up to a romantic brook, rushing down through a gorge bordered by moss-grown trees and carpeted by ferns and lichens in all its nooks and corners. This brook took its rise in a small lake lying some half a mile behind the beach. The collections made along the shore in this excursion were large and various: star-fish, volutas, sea-urchins, sea-anemones, medusae, doris; many small fishes, also, from the tide-pools, beside a number drawn in the seine.

Later in the day, when the party had assembled around the beach fire for rest and refreshment, before returning to the vessel, their lunch was interrupted by strange and unexpected guests. A boat rounded the point of the beach, and, as it came nearer, proved to be full of Fuegian natives, men, women, chil-

dren, and dogs, their invariable companions. The men alone landed, some six or seven in number, and came toward the tent. Nothing could be more coarse and repulsive than their appearance, in which the brutality of the savage was in no way redeemed by physical strength or manliness. They were almost naked, for the short, loose skins tied around the neck, and hanging from the shoulders, over the back, partly to the waist, could hardly be called clothing. With swollen bodies, thin limbs, and stooping forms; with a childish, yet cunning, leer on their faces, they crouched over the fire, spreading their hands toward its genial warmth, and all shrieking at once, "Tabac! tabac!" and "Galleta!" — biscuit. Tobacco there was none; but the remains of the lunch, such as it was, — hard bread and pork, — was distributed among them, and they greedily devoured it. Then the one who, judging from a certain deference paid him by the others, might be the chief, or leader, seated himself on a stone and sang in a singular kind of monotonous, chanting tone. The words, as interpreted by the gestures and expressions, seemed to be an improvisation concerning the strangers they had found upon the beach, and were

evidently addressed to them. There was something curious in the character of this Fuegian song. Rather recitative than singing, the measure had, nevertheless, certain divisions or pauses, as if to mark a kind of rhythm. It was brought to a close at regularly recurring intervals, and ended always in the same way, and on the same note, with a rising inflection of the voice. When the song was finished, a certain surprise and expectancy in the listeners kept them silent. This seemed to trouble the singer, who looked round with a comical air of inquiring disappointment. Thus reminded, the audience were quick to applaud, and then he laughed with pleasure, imitated the clapping of the hands in an awkward way, and nothing loth, began to sing again.

The recall gun from the Hassler brought this strange scene to a close, and the party hastened down to the beach, closely followed by their guests, who still clamorously demanded tobacco. Meanwhile the women had brought the boat close to that of the Hassler at the landing. They all began to laugh, talk, and gesticulate, and seemed a noisy crew, chattering unceasingly, with amazing rapidity, and all together. Their boat, with the babies and dogs to add to the tumult, was a perfect

babel of voices. They put off at once, keeping as close as they could to the Hassler boat, and reaching the vessel almost at the same time. They were not allowed to come on board, but tobacco and biscuit, as well as bright calico and beads for the women, were thrown down to them. They scrambled and snatched fiercely, like wild animals, for whatever they could catch. They had some idea of barter, for when they found they had received all that they were likely to get gratuitously, they held up bows and arrows, wicker baskets, birds, and the large sea-urchins, which are an article of food with them. Even after the steamer had started, they still clung to the side, praying, shrieking, screaming, for more "tabac." When they found it a hopeless chase, they dropped off, and began again the same chanting recitative, waving their hands in farewell.

Always interested in the comparative study of the races, Agassiz regretted that he had no other opportunity of observing the natives of this region and comparing them with the Indians he had seen elsewhere, in Brazil and in the United States. It is true that he and his companions, when on shore, frequently came upon their deserted camps, or single empty

huts; and their canoes followed the Hassler several times, but never when it was convenient to stop and let them come up with the vessel. This particular set were not in a canoe, but in a large boat of English build. Probably they had stolen it, or had found it, perhaps, stranded on the shore. They are usually, however, in canoes of their own making. One can only wonder that people ingenious enough to construct canoes so well modeled and so neatly and strongly put together, should have invented nothing better in the way of a house than a hut built of flexible branches, compared with which a wigwam is an elaborate dwelling. These huts are hood-like in shape, and too low for any posture but that of squatting or lying down. In front is always a scorched spot on the ground, where their handful of fire has smouldered; and at one side, a large heap of empty shells, showing that they had occupied this place until they had exhausted the supply of mussels, on which they chiefly live. When this is the case, they move to some other spot, gather a few branches, reconstruct their frail shelter, and continue the same life. Untaught by their necessities, they wander thus, naked and homeless, in snow, mist, and rain, as they have done

for ages, asking of the land only a strip of beach and a handful of fire; and of the ocean, shell-fish enough to save them from starvation.

The Hassler had now fairly entered upon Smythe's Channel, and was anchored at evening (March 27th) in Otway Bay, a lake-like harbor, broken by islands. Mount Burney, a noble, snow-covered mountain, corresponding to Mount Sarmiento in grandeur of outline, was in full view, but was partially veiled in mist. On the following day, however, the weather was perfect for the sail past Sarmiento Range and Snowy Glacier, which were in sight all day. Blue could not be more deep and pure, nor white more spotless, than their ice and snow-fields. Toward the latter part of the day, an immense expanse of snow opened out a little beyond Snowy Range. It was covered with the most curious snow hummocks, forming high cones over the whole surface, their shadows slanting over the glittering snow in the afternoon sunshine. They were most fantastic in shape, and some fifty or sixty in number. At first sight, they resembled heaped-up mounds or pyramids of snow; but as the vessel approached, one group of them, so combined as to simulate a

fortification, showed a face of rock where the snow had been blown away, and it seemed therefore probable that all were alike, — snow-covered pinnacles of rock.

The evening anchorage on the 28th was in Mayne's Harbor, a pretty inlet of Owen's Island. Here the vessel was detained for twenty-four hours by the breaking of the reversing rod. The engineers repaired it to the best of their ability, with such apparatus as they had, but it was a source of anxiety till a port was reached where a new one could be supplied. The detention, had it not been for such a cause, was welcome to the scientific party. Agassiz found the rounded and moutonnées surfaces and the general modeling of the outlines of ice no less marked here than in the Strait; and in a ramble over the hills above the anchorage, M. de Pourtalès came upon very distinct glacial scorings and furrows on dikes and ledges of greenstone and syenite. They were perfectly regular, and could be connected by their trend from ledge to ledge, across intervening spaces of softer decomposed rock, from which all such surface markings had disappeared.

The country above Mayne's Harbor was pretty, though somewhat barren. Beyond the

narrow belt of woods bordering the shore, the walking was over soggy hummocks, with little growth upon them except moss, lichens, and coarse marsh grass. These were succeeded by ridges of crumbling rock, between which were numerous small lakes. The land seemed very barren of life. Even the shores of the ponds were hardly inhabited. No song of bird or buzz of insect broke the stillness. Rock after rock was turned over in the vain expectation of finding living things on the damp under side at least; and the cushions of moss were broken up in the same fruitless chase. All was barren and lifeless. Not so on the shore, where the collecting went on rapidly. Dredge and nets were at work all the morning, and abundant collections were made also from the little nooks and inlets of the beach. Agassiz found two new jelly-fishes, and christened them at once as the locality suggested, one for Captain Mayne, the other for Professor Owen. Near the shore, birds also seemed more abundant. A pair of kelp-geese and a steamer duck were brought in, and one of the officers reported humming-birds flitting across the brook from which the Hassler's tanks were filled.

Early on the morning of the 30th, while

mountains and snow-fields, woodland and water, still lay between moonlight and sunrise, the Hassler started for Tarn Bay. It was a beautiful Easter Sunday, with very little wind, and a soft sky, broken by few clouds. But such beginnings are too apt to be delusive in this region of wet and fog, and a heavy rain, with thick mist, came up in the afternoon. That night, for the first time, the Hassler missed her anchorage, and lay off the shore near an island, which afforded some protection from the wind. A forlorn hope was detailed to the shore, where a large fire was kept burning all night, that the vessel might not lose her bearings and drift away. In the morning all was right again, and she kept on her course to Rowlet Narrows.

This passage is formed by a deep gorge, cleft between lofty walls over which many a waterfall foams from reservoirs of snow above. Agassiz observed two old glacier beds on the western side of the pass — two shallow depressions, lying arid and scored between swelling wooded ridges. He had not met in all the journey a better locality for the study of glacial effects than here. The sides of the channel show these traces throughout their whole length. In this same neighborhood, as a con-

spicuous foreground on the shore of Indian Reach, to the south of Lackawanna Cove, is a large moraine resembling the "horse-backs," in the State of Maine, New England. The top was as level as a railroad embankment. The anchorage for the night was in Eden Harbor, and for that evening, at least, it was lovely enough to deserve its name. The whole expanse of its land-locked waters, held between mountains and broken by islands, was rosy and purple in the setting sun. The gates of the garden were closed, however, not by a flaming sword, but by an impenetrable forest, along the edge of which a scanty rim of beach hardly afforded landing or foothold. The collections here, therefore, were small; but a good haul was made with the trawl net, which gathered half-a-dozen species of echinoderms, some small fishes, and a number of shells. Fog detained the vessel in Eden Harbor till a late hour in the morning, but the afternoon was favorable for the passage through the English Narrows, the most contracted part of Smythe's Channel. It is, indeed, a mere mountain defile, through which the water rushes with such force that, in navigating it, great care was required to keep the vessel off the rocks. Her anchorage at the close of the

day was in Connor's Cove, a miniature harbor not unlike Borja Bay in the Strait. It was a tranquil retreat. The water-birds seemed to find it so, for the steamer ducks were trailing their long wakes through the water, and a large kind of stormy petrel sailed up to the vessel, and almost put himself into the hands of the sailors, with whom he remained an unresisting prisoner.

Geologically, Agassiz found Connor's Cove of especial interest. It runs east and west, opening on the eastern side of the channel; but the knolls, that is to say, the rounded surfaces at its entrance, are furrowed across the cove, at right angles with it. In other words, the movement of the ice, always from south to north, has been with Smythe's Channel, and across the Strait of Magellan. Indeed it seemed to Agassiz that all the glacial agency in Smythe's Channel, the trend of the furrows, the worn surfaces whereon they were to be found, and the steepness of southern exposures as compared with the more rounded opposite slopes, pointed to the same conclusion.

On the third of April Agassiz left with regret this region of ocean and mountain, glacier, snow-field, and forest. The weeks he had

spent there were all too short for the work he had hoped to do. Yet, trained as he was in glacial phenomena, even so cursory an observation satisfied him that in the southern, as in the northern hemisphere, the present glaciers are but a remnant of the ancient ice-period.

After two days of open sea and head winds, the next anchorage was in Port San Pedro, a very beautiful bay opening on the north side of Corcovado Gulf, with snow mountains in full sight; the Peak of Corcovado and a wonderfully symmetrical volcanic mountain, Melimoya, white as purest marble to the summit, were clearly defined against the sky. Forests clothed the shore on every side, and the shelving beach met the wood in a bank of wild Bromelia, most brilliant in color. Not only were excellent collections made on this beach, but the shore was strewn with large accumulations of erratics. Among them was a green epidotic rock which Agassiz had traced to this spot from the Bay of San Antonio on the Patagonian coast, without ever finding it in place. Some of the larger boulders had glacial furrows and scratches upon them, and all the hills bordering the shore were rounded and moutonnée. One of the great charms for Agassiz in the scenery of all

this region, and especially in the Strait of Magellan, was a kind of home feeling that it gave him. Although the mountains rose from the ocean, instead of from the plain as in Switzerland, yet the snow-fields and the glaciers carried him back to his youth. To him, the sunset of this evening in the Port San Pedro, with the singular transparent rose color over the snow mountains, and the soft succeeding pallor, was the very reproduction of an Alpine sunset.

The next morning brought a disappointment. From this point Agassiz had hoped to continue the voyage by the inside passage between the main-land and the island of Chiloe. This was of importance to him, on account of its geological relation to Smythe's Channel and the Strait of Magellan. In the absence of any good charts of the channel, the Captain, after examining the shoals at the entrance, was forced to decide, almost as much to his own regret as to that of Agassiz, not to attempt the further passage. Keeping up the outer coast of Chiloe, therefore, the vessel anchored before Ancud on the 8th of April. It was a heavenly day. The volcanic peak of Osorno and the whole snowy Cordilleras were unveiled. The little town above the harbor,

with its outlying farms on the green and fertile hills around, seemed like the very centre of civilization to people who had been so long out of the world. It is said to rain in Ancud three hundred and sixty-five days in the year. But on this particular afternoon it was a very sunny place, and the inhabitants seemed to avail themselves of their rare privilege. Groups of Indians, who had come across the river in the morning to sell their milk in the town, were resting in picturesque groups around their empty milk-cans, the women wrapped in their long shawls, the men in their ponchos and slouched hats; the country people were driving out their double teams of strong, powerful oxen harnessed to wooden troughs filled with manure for the fields; the washerwomen were scrubbing and beating their linen along the roadside; the gardens of the poorest houses were bright with large shrubs of wild fuchsia, and, altogether, the aspect of the little place was cheerful and pretty. Agassiz had but two or three hours for a look at the geology. Even this cursory glance sufficed to show him that the drift materials, even to their special mineralogical elements, were the same as in the Magellan Strait. Here they rested, however, on volcanic soil.

Stopping at Lota for coal, but not long enough for any scientific work, the Hassler entered Concepcion Bay on the 15th April, and anchored near Talcahuana, where she was to remain some three weeks for the repair of her engine. This quaint, primitive little town is built upon one of the finest harbors on the Pacific coast. Agassiz was fortunate in finding, through the kindness of Captain Johnson, a partially furnished house, where several large vacant rooms, opening on the "patio," served admirably as scientific laboratories. Here, then, he established himself with his assistants. It was soon understood that every living thing would find a market with him, and all the idle urchins about the town flocked to the house with specimens. An unceasing traffic of birds, shells, fish, etc., went on there from morning to night, and to the various vendors were added groups of Indians coming to have their photographs taken. There were charming excursions and walks in the neighborhood, and the geology of the region was so interesting that it determined Agassiz to go by land from Talcahuana to Valparaiso, on a search after any glacial tracks that might be found in the valley lying between the Cordillera of the Andes and the

Coast Range. Meanwhile the Hassler was to go on a dredging expedition to the island of Juan Fernandez, and then proceed to Valparaiso, where Agassiz was to join her a fortnight later. Although this expedition was under the patronage of the Coast Survey, the generosity of Mr. Thayer, so constantly extended to scientific aims, had followed Agassiz on this second journey. To his kindness he owed the possibility of organizing an excursion apart from the direct object of the voyage. This change of plan and its cause is told in the following extract from his general report to Professor Peirce: —

"*April 27th.* While I was transcribing my Report, Pourtalès came in with the statement that he had noticed the first indication of an Andean glacier in the vicinity. I have visited the locality twice since. It is a magnificent polished surface, as well preserved as any I have ever seen upon old glaciated ground or under glaciers of the present day, with well-marked furrows and scratches. Think of it! a characteristic surface, indicating glacier action, in lat. 37° S., at the level of the sea! The place is only a few feet above tide level, upon the slope of a hill on

which stand the ruins of a Spanish fort, near the fishermen's huts of San Vicente, which lies between Concepcion Bay and the Bay of Aranco. Whether the polished surface is the work of a glacier descending from the Andes to the sea-shore or not, I have not yet been able to determine. I find no volcanic pebbles or boulders in this vicinity, which, after my experience in San Carlos, I should expect all along the shore, if the glaciers of the Andes had descended to the level of the ocean, in this part of the country. The erratics here have the character of those observed farther south. It is true the furrows and scratches of this polished surface run mainly from east to west; but there are some crossing the main trend, at angles ranging from 20° to 30°, and running S. E. N. W. Moreover, the magnetic variation is 18° 3′ at Talcahuano April 23d, the true meridian bearing to the right of the magnetic. I shall soon know what to make of this, as I start to-morrow for the interior, to go to Santiago and join the ship again at Valparaiso. I have hired a private carriage, to be able to stop whenever I wish so to do. I also take a small seine to fish for fresh water fishes in the many streams intervening between this place and Valparaiso. The trend

of the glacial scratches in San Vicente reminds me of a fact I have often observed in New England near the sea-shore, where the glacial furrows dip to a considerable extent eastward toward the deep ocean, while further inland their trend is more regular and due North and South. . . .

"I had almost forgotten to say that I have obtained unquestionable evidence of the cretaceous age of the coal deposits of Lota and the adjoining localities, north and south, which are generally supposed to be tertiary lignites. They are overlaid by sandstone containing Baculites! I need not adduce other evidence to satisfy geologists of the correctness of my assertion. I have myself collected a great many of these fossils, in beds resting upon coal-seams. Ever truly yours,

"LOUIS AGASSIZ."

On the 28th of April, then, Agassiz left Talcahuana, accompanied by Mrs. Agassiz, and by Dr. Steindachner, who was to assist him in making collections along the way. They were to travel post, along the diligence road, until they reached Curicu, within half a day of Santiago, where railroad travel began. It was a beautiful journey, and though the

rainy season was impending, the fair weather was uninterrupted. The way lay for the most part through an agricultural district of corn, wheat, and vineyards. In this strange land, where seasons are reversed, and autumn has changed places with spring, the work of harvest and vintage was just going on. The road was full of picturesque scenes: troops of mules might be met, a hundred at a time, laden with corn-sacks; the queer, primitive carts of the country creaked along, carrying huge wine-jars filled with the fresh new juice of the grape; the road was gay with country people in their holiday dresses; the women, who wore their bright shawls like a kind of mantle, were sometimes on foot and sometimes pillioned behind the men, who were invariably on horseback, and whose brilliant ponchos and fine riding added to the impression of life and color. Rivers and streams were frequent; and as there were no bridges, the scenes at the fords, sometimes crossed on rafts, sometimes on flat boats, worked by ropes, were exciting and picturesque. For rustic interiors along the road side, there were the huts of the working people, rough trellises of tree-trunks interwoven with branches; green as arbors while fresh, a coarse thatch when dry. There was

always a large open space in front, sheltered by the projecting thatch of the house, and furnished sometimes with a rough table and benches. Here would be the women at their work, or the children at play, or sometimes the drovers taking their lunch of tortillas and wine, while their animals munched their mid-day meal hard by. The scenery was often fine. On the third day the fertile soil, watered by many rivers, was exchanged for a sandy plain, broken by a thorny mimosa scattered over the surface. This plain lay between the Cordillera of the Andes and the Coast Range. As the road advanced farther inland, the panorama of the Cordilleras became more and more striking. In the glow of the sunset, the peaks of the abrupt, jagged walls and the volcano-like summits were defined against the sky in all their rugged beauty. There was little here to remind one of the loveliness of the Swiss Alps. With no lower green slopes, no soft pasturage grounds leading gently up to rocky heights, the Andes, at least in this part of their range, rise arid, stern, and bold from base to crest, a fortress wall unbroken by tree or shrub, or verdure of any kind, and relieved only by the rich and varied coloring of the rock.

The lodgings for the night were found in small towns along the road, Tomé, Chilian, Linarez, Talca, Curicu, and once, when there was no inn within reach, at a hospitable hacienda.

A brief sketch of the geological observations made on this excursion is found in a letter from Agassiz to Mr. Peirce. He never wrote out, as he had intended to do, a more detailed report.

OFF GAUTEMALA, *July* 29, 1872.

MY DEAR PEIRCE,— . . . I have another new chapter concerning glacial phenomena, gathered during our land-journey from Talcahuana to Santiago. It is so complicated a story that I do not feel equal now to recording the details in a connected statement, but will try to give you the main facts in a few words.

There is a broad valley between the Andes and the Coast Range, the valley of Chilian, extending from the Gulf of Ancud, or Port de Mott, to Santiago and farther north. This valley is a continuation, upon somewhat higher level, of the channels which, from the Strait of Magellan to Chiloë, separate the islands from the main-land, with the sole interruption of Tres Montes. Now this great valley,

extending for more than twenty-five degrees of latitude, is a *continuous glacier bottom*, showing plainly that for its whole length the great southern ice-sheet has been retreating southward in it. I could find nowhere any indication that glaciers descending from the Andes had crossed this valley and reached the shores of the Pacific. In a few brief localities only did I notice Andean, *i. e.* volcanic, erratics upon the loose materials filling the old glacier bottom. Between Curicu and Santiago, however, facing the gorge of Tenõn, I saw two distinct lateral moraines, parallel to one another, chiefly composed of volcanic boulders, resting upon the old drift, and indicating by their position the course of a large glacier that once poured down from the Andes of Tenõn, and crossed the main valley, without, however, extending beyond the eastern slope of the Coast Range. These moraines are so well marked that they are known throughout the country as the cerillos of Tenõn, but nobody suspects their glacial origin; even the geologists of Santiago assign a volcanic origin to them. What is difficult to describe in this history are the successive retrograde steps of the great southern ice-field that, step by step, left larger or smaller

tracts of the valley to the north of it free of ice, so that large glacial lakes could be formed, and seem, indeed, always to have existed along the retreating edge of the great southern glacier. The natural consequence is that there are everywhere stratified terraces without border barriers (since these were formed only by the ice that has vanished), resting at successively higher or lower levels, as you move north or south, upon unstratified drift of older date; the northernmost of these terraces being the oldest, while those further south belong to later steps in the waning of the ice-fields. From these data I infer that my suggestion concerning the trend of the striæ upon the polished and glaciated surface of the vicinity of Talcahuana, alluded to in the postscript of my last letter, is probably correct. . . .

At Santiago Agassiz rested a day or two. Here, as everywhere throughout the country, he met with the greatest kindness and cordiality. A public reception and dinner were urged upon him by the city, but his health obliged him to decline this and like honors elsewhere. Among the letters awaiting him here, was one which brought him a pleasant

surprise. It announced his election as Foreign Associate of the Institute of France, — "one of the eight." As the crowning honor of his scientific career, this was, of course, very gratifying to him. In writing soon after to the Emperor of Brazil, who had expressed a warm interest in his election, he says: "The distinction pleased me the more because so unexpected. Unhappily it is usually a brevet of infirmity, or at least of old age, and in my case it is to a house in ruins that the diploma is addressed. I regret it the more because I have never felt more disposed for work, and yet never so fatigued by it."

From Santiago Agassiz proceeded to Valparaiso, where he rejoined the ship's company. The events of their cruise had been less satisfactory than those of his land-journey, for, owing to the rottenness of the ropes, produced by dampness, the hauls of the dredge from the greatest depths had been lost. Several pauses for dredging in shallower waters were made with good success, nevertheless, on the way up the coast to Callão. From there the Hassler put out to sea once more, for the Galapagos, arriving before Charles Island on the 10th of June, and visiting in succession Albemarle, James, Jarvis, and Indefatigable islands.

Agassiz enjoyed extremely his cruise among these islands of such rare geological and zoological interest. Purely volcanic in character, and of very recent formation, they yet support a fauna and flora quite their own, very peculiar and characteristic. Albemarle Island was, perhaps, the most interesting of all. It is a barren mountain rising from the sea, its base and slope covered with small extinct craters. No less than fifty — some perfectly symmetrical, others irregular, as if blasted out on one side — could be counted from the deck as the vessel neared the shore. Indeed, the whole island seemed like some subterranean furnace, of which these craters were the chimneys. The anchorage was in Tagus Sound, a deep, quiet bay, less peaceful once, for its steep sides are formed by the walls of an old crater.

The next day, June 15, was spent by the whole scientific party in a ramble on shore. The landing was at the foot of a ravine. Climbing its left bank, they were led by a short walk to the edge of a large crater, which held a beautiful lake in its cup. It was, in fact, a crater within a crater, for a second one, equally symmetrical, rose outside and above it. Following the brink of this lake to

its upper end, they struck across to the head of the ravine. It terminated in a ridge, which looked down upon an immense field or sea of hardened lava, spreading over an area of several miles till it reached the ocean. This ancient bed of lava was full of the most singular and fantastic details of lava structure. It was a field of charred ruins, among which were more or less open caves or galleries, some large enough to hold a number of persons standing upright, others hardly allowing room to creep through on hands and knees. Rounded domes were common, sometimes broken, sometimes whole; now and then some great lava bubble was pierced with a window blasted out of the side, through which one could look down to the floor of a deep, underground hollow.

The whole company, some six or eight persons, lunched in one of the caves, resting on the seats formed by the ledges of lava along its sides. It had an entrance at either end, was some forty feet long, at least ten feet high in the centre, and perhaps six or eight feet wide. Probably never before had it served as a banqueting hall. Such a hollow tunnel or arch had been formed wherever the interior of a large mass of lava, once cooled,

had become heated again, and had flowed out, leaving the outside crust standing. The whole story of this lava bed is so clearly told in its blackened and extinct remains, that it needs no stretch of the imagination to recreate the scene. It is again a heaving, palpitating sheet of fire; the dead slags are aglow, and the burned-out furnaces cast up their molten, blazing contents, as of old. Now it is the home of the large red and orange-colored iguanas, of which a number were captured, both alive and dead. These islands proved, indeed, admirable collecting grounds, the more interesting from the peculiarity of their local fauna.

FROM AGASSIZ TO PROFESSOR PEIRCE.

OFF GUATEMALA, *July* 29.

. . . Our visit to the Galapagos has been full of geological and zoölogical interest. It is most impressive to see an extensive archipelago, of *most recent origin*, inhabited by creatures so different from any known in other parts of the world. Here we have a positive limit to the length of time that may have been granted for the transformation of these animals, if indeed they are in any way derived from others dwelling in different parts

of the world. The Galapagos are so recent that some of the islands are barely covered with the most scanty vegetation, itself peculiar to these islands. Some parts of their surface are entirely bare, and a great many of the craters and lava streams are so fresh, that the atmospheric agents have not yet made an impression on them. Their age does not, therefore, go back to earlier geological periods; they belong to our times, geologically speaking. Whence, then, do their inhabitants (animals as well as plants) come? If descended from some other type, belonging to any neighboring land, then it does not require such unspeakably long periods for the transformation of species as the modern advocates of transmutation claim; and the mystery of change, with such marked and characteristic differences between existing species, is only increased, and brought to a level with that of creation. If they are autochthones, from what germs did they start into existence? I think that careful observers, in view of these facts, will have to acknowledge that our science is not yet ripe for a fair discussion of the origin of organized beings. . . .

There is little to tell for the rest of the

voyage that cannot be condensed into a few words. There was a detention for despatches and for Coast Survey business at Panama, — a delay which was turned to good account in collecting, both in the Bay and on the Isthmus. At San Diego, also, admirable collections were made, and pleasant days were spent. This was the last station on the voyage of the Hassler. She reached her destination and entered the Golden Gate on the 24th of August, 1872. Agassiz was touched by his reception in San Francisco. Attentions and kindnesses were showered upon him from all sides, but his health allowed him to accept only such hospitalities as were of the most quiet and private nature. He passed a month in San Francisco, but was unable to undertake any of the well-known excursions to the Yosemite Valley or the great trees. Rest and home became every day more imperative necessities.

CHAPTER XXV.

1872–1873 : ÆT. 65–66.

Return to Cambridge. — Summer School proposed. — Interest of Agassiz. — Gift of Mr. Anderson. — Prospectus of Penikese School. — Difficulties. — Opening of School. — Summer Work. — Close of School. — Last Course of Lectures at Museum. — Lecture before Board of Agriculture. — Illness. — Death. — Place of Burial.

In October, 1872, Agassiz returned to Cambridge. To arrange the collections he had brought back, to write a report of his journey and its results, to pass the next summer quietly at his Nahant laboratory, continuing his work on the Sharks and Skates, for which he had brought home new and valuable material, seemed the natural sequence of his year of travel. But he found a new scheme of education on foot; one for which he had himself given the first impulse, but which some of his younger friends had carefully considered and discussed in his absence, being confident that with his help it might be accomplished. The plan was to establish a summer school

of natural history somewhere on the coast of Massachusetts, where teachers from our schools and colleges could make their vacations serviceable, both for work and recreation, by the direct study of nature. No sooner was Agassiz once more at home than he was confronted by this scheme, and he took it up with characteristic ardor. Means there were none, nor apparatus, nor building, nor even a site for one. There was only the ideal, and to that he brought the undying fervor of his intellectual faith. The prospectus was soon sketched, and, once before the public, it awakened a strong interest. In March, when the Legislature of Massachusetts made their annual visit to the Museum of Comparative Zoölogy, Agassiz laid this new project before them as one of deep interest for science in general, and especially for schools and colleges throughout the land. He considered it also an educational branch of the Museum, having, as such, a claim on their sympathy, since it was in the line of the direct growth and continuance of the same work. Never did he plead more eloquently for the cause of education. His gift as a speaker cannot easily be described. It was born of conviction, and was as simple as it

was impassioned. It kept the freshness of youth, because the things of which he spoke never grew old to him, but moved him to the last hour of his life as forcibly as in his earlier years.

This appeal to the Legislature, spoken in the morning, chanced to be read in the evening papers of the same day by Mr. John Anderson, a rich merchant of New York. It at once enlisted his sympathy both for the work and for the man. Within the week he offered to Agassiz, as a site for the school, the island of Penikese, in Buzzard's Bay, with the buildings upon it, consisting of a furnished dwelling-house and barn. Scarcely was this gift accepted than he added to it an endowment of $50,000 for the equipment of the school. Adjectives belittle deeds like these. The bare statement says more than the most laudatory epithets.

Agassiz was no less surprised than touched at the aid thus unexpectedly offered. In his letter of acknowledgment he says: "You do not know what it is suddenly and unexpectedly to find a friend at your side, full of sympathy, and offering support to a scheme which you have been trying to carry out under difficulties and with very scanty means.

I feel grateful to you for making the road so easy, and I believe you will have the permanent gratitude of scientific men here and elsewhere, for I have the utmost confidence that this summer school will give valuable opportunities for original research, as well as for instruction." At Agassiz's suggestion the school was to bear the name of "The Anderson School of Natural History." Mr. Anderson wished to substitute the name of Agassiz for his own. This Agassiz absolutely refused to permit, saying that he was but one of many scientific men who had already offered their services to the school for the coming summer, some of whom would, no doubt, continue to work for it in the future, and all of whom would be equally indebted to Mr. Anderson. It was, therefore, most suitable that it should bear his name, and so it was agreed.

Thus the material problem was solved. Name and habitation were found; it remained only to organize the work for which so fitting a home had been provided. Mr. Anderson's gift was received toward the close of March, and, in the course of the following month, the preliminaries were concluded, and the property was transferred to the trustees of the Anderson School.

PENIKESE

Few men would have thought it feasible to build dormitories and laboratories, and provide working apparatus for fifty pupils as well as for a large corps of teachers, between May and July. But to Agassiz no obstacles seemed insurmountable where great aims were involved, and the opening of the school was announced for the 8th of July. He left Boston on Friday, the 4th of July, for the island. At New Bedford he was met by a warning from the architect that it would be simply impossible to open the school at the appointed date. With characteristic disregard of practical difficulties, he answered that it must be possible, for postponement was out of the question. He reached the island on Saturday, the 5th, in the afternoon. The aspect was certainly discouraging. The dormitory was up, but only the frame was completed; there were no floors, nor was the roof shingled. The next day was Sunday. Agassiz called the carpenters together. He told them that the scheme was neither for money, nor for the making of money; no personal gain was involved in it. It was for the best interests of education, and for that alone. Having explained the object, and stated the emergency, he asked whether, under these cir-

cumstances, the next day was properly for rest or for work. They all answered "for work." They accordingly worked the following day from dawn till dark, and by night-fall the floors were laid. On Monday, the 7th, the partitions were put up, dividing the upper story into two large dormitories; the lower into sufficiently convenient working-rooms. On Tuesday morning (the 8th), with the help of a few volunteers, chiefly ladies connected with the school, who had arrived a day or two in advance, the dormitories, which were still encumbered by shavings, sawdust, etc., were swept, and presently transformed into not unattractive sleeping-halls. They were divided by neat sets of furniture into equal spaces, above each of which was placed the name of the person to whom it was appropriated. When all was done, the large open rooms, with their fresh pine walls, floors, and ceilings, the rows of white beds down the sides, and the many windows looking to the sea, were pretty and inviting enough. If they somewhat resembled hospital wards, they were too airy and cheerful to suggest sickness either of body or mind.

Next, a large barn belonging to Mr. Anderson's former establishment was cleared, and a

new floor laid there also. This was hardly finished (the last nails were just driven) when the steamer, with its large company, touched the wharf. There was barely time to arrange the seats and to place a table with flowers where the guests of honor were to sit, and Agassiz himself was to stand, when all arrived. The barn was, on the whole, not a bad lecture-room on a beautiful summer day. The swallows, who had their nests without number in the rafters, flew in and out, and twittered softly overhead; and the wide doors, standing broadly open to the blue sky and the fresh fields, let in the sea-breeze, and gave a view of the little domain. Agassiz had arranged no programme of exercises, trusting to the interest of the occasion to suggest what might best be said or done. But, as he looked upon his pupils gathered there to study nature with him, by an impulse as natural as it was unpremeditated, he called upon them to join in silently asking God's blessing on their work together. The pause was broken by the first words of an address no less fervent than its unspoken prelude.[1]

Thus the day, which had been anticipated

[1] This whole scene is fitly told in Whittier's poem, *The Prayer of Agassiz.*

with so much anxiety, passed off, unclouded by any untoward accident, and at evening the guests had departed. Students and teachers, a company of some fifty or sixty persons, were left to share the island with the sea-gulls whose haunt it was.

We will not enter into the daily details of the school. It was a new phase of teaching, even for Agassiz, old as he was in the work. Most of his pupils were mature men and women, some of whom had been teachers themselves for many years. He had, therefore, trained minds to deal with, and the experience was at that time as novel as it was interesting. The novelty has worn off now. Summer schools for advanced students, and especially for teachers, have taken their place in the general system of education; and, though the Penikese school may be said to have died with its master, it lives anew in many a sea-side laboratory organized on the same plan, in summer schools of Botany and field classes of Geology. The impetus it gave was not, and cannot be, lost, since it refreshed and vitalized methods of teaching.

Beside the young men who formed his corps of teachers, among whom the resident professors were Dr. Burt G. Wilder, of Cornell Uni-

versity, and Professor Alpheus S. Packard, now of Brown University, Agassiz had with him some of his oldest friends and colleagues. Count de Pourtalès was there, superintending the dredging, for which there were special conveniences, Mr. Charles G. Galloupe having presented the school with a yacht for the express purpose. This generous gift gave Agassiz the greatest pleasure, and completed the outfit of the school as nothing else could have done. Professor Arnold Guyot, also, — Agassiz's comrade in younger years, — his companion in many an Alpine excursion, — came to the island to give a course of lectures, and remained for some time. It was their last meeting in this world, and together they lived over their days of youthful adventure. The lectures of the morning and afternoon would sometimes be followed by an informal meeting held on a little hill, which was a favorite resort at sunset. There the whole community gathered around the two old friends, to hear them talk of their glacial explorations, one recalling what the other had forgotten, till the scenes lived again for themselves, and became almost equally vivid for their listeners. The subject came up naturally, for, strange to say, this island in a

New England bay was very suggestive of glacial phenomena. Erratic materials and boulders transported from the north were scattered over its surface, and Agassiz found the illustrations for his lectures on this topic ready to his hand. Indeed, some of his finest lectures on the ice-period were given at Penikese.

Nothing could be less artificial, more free from constraint or formality, than the intercourse between him and his companions of this summer. He was at home with every member of the settlement. Ill-health did not check the readiness of his sympathy; languor did not chill the glow of his enthusiasm. All turned to him for help and inspiration. Walking over their little sovereignty together, hunting for specimens on its beaches, dredging from the boats, in the laboratory, or the lecture-room, the instruction had always the character of the freest discussion. Yet the work, although combined with out-of-door pleasures, and not without a certain holiday element, was no play. On the part of the students, the application was close and unremitting; on the part of the teachers, the instruction, though untrammeled by routine, was sustained and systematic.

Agassiz himself frequently gave two lec-

tures a day. In the morning session he would prepare his class for the work of the day; in the afternoon he would draw out their own observations by questions, and lead them, by comparison and combination of the facts they had observed, to understand the significance of their results. Every lecture from him at this time was a lesson in teaching as well as in natural history, and to many of his hearers this gave his lectures a twofold value, as bearing directly upon their own occupation. In his opening address he had said to them: "You will find the same elements of instruction all about you wherever you may be teaching. You can take your classes out, and give them the same lessons, and lead them up to the same subjects you are yourselves studying here. And this mode of teaching children is so natural, so suggestive, so true. That is the charm of teaching from Nature herself. No one can warp her to suit his own views. She brings us back to absolute truth as often as we wander."

This was the bright side of the picture. Those who stood nearest to Agassiz, however, felt that the strain not only of work, but of the anxiety and responsibility attendant upon a new and important undertaking, was peril-

ous for him. There were moments when this became apparent, and he himself felt the danger. He persevered, nevertheless, to the end of the summer, and only left Penikese when the school broke up.

In order to keep the story of this final effort unbroken, some events of great interest to Agassiz and of importance to the Museum have been omitted. In the spring the Museum had received a grant of $25,000 from the Legislature. To this was added $100,000, a birthday gift to Agassiz in behalf of the institution he so much loved. This last sum was controlled by no official body and was to be expended at his own good will and pleasure, either in collections, publications, or scientific assistance, as seemed to him best. He therefore looked forward to a year of greater ease and efficiency in scientific work than he had ever enjoyed before. On returning from Penikese, full of the new possibilities thus opened to him, he allowed himself a short rest, partly at the sea-shore, partly in the mountains, and was again at his post in the Museum in October.

His last course of lectures there was on one of his favorite topics, — the type of Radiates as connected with the physical history of the

earth, from the dawn of organic life till now. In his opening lecture he said to his class: "You must learn to look upon fossil forms as the antiquarian looks upon his coins. The remains of animals and plants have the spirit of their time impressed upon them, as strongly as the spirit of the age is impressed upon its architecture, its literature, its coinage. I want you to become so familiar with these forms, that you can read off at a glance their character and associations." In this spirit his last course was conceived. It was as far-reaching and as clear as usual, nor did his delivery evince failure of strength or of mental power. If he showed in any way the disease which was even then upon him, it was by an overtension of the nerves, which gave increased fervor to his manner. Every mental effort was, however, succeeded by great physical fatigue.

At the same time he had undertaken a series of articles in the "Atlantic Monthly," entitled, "Evolution and Permanence of Type." They were to have contained his own convictions regarding the connection between all living beings, upon which his studies had led him to conclusions so different from the philosophy of the day. Of these papers, only

one was completed. It was his last word upon science; the correction of the proof-sheets was the last act of his working life, and the article was published after his death. In it he claimed that the law of evolution, in a certain sense as true to him as to any so-called evolutionist, was a law "controlling development, and keeping types within appointed cycles of growth." He maintained that this law acts within definite limits, and never infringes upon the great types, each one of which is, in his view, a structural unit in itself. Even metamorphoses, he adds, "have all the constancy and invariability of other modes of embryonic growth, and have never been known to lead to any transition of one species into another." Of heredity he says: "The whole subject of inheritance is exceedingly intricate, working often in a seemingly capricious and fitful way. Qualities, both good and bad, are dropped as well as acquired, and the process ends sometimes in the degradation of the type, and the survival of the unfit rather than the fittest. The most trifling and fantastic tricks of inheritance are quoted in support of the transmutation theory; but little is said of the sudden apparition of powerful original qualities, which almost always rise like pure creations, and are

gone with their day and generation. The noblest gifts are exceptional, and are rarely inherited; this very fact seems to me an evidence of something more and higher than mere evolution and transmission concerned in the problem of life. In the same way the matter of natural and sexual selection is susceptible of very various interpretations. No doubt, on the whole, Nature protects her best. But it would not be difficult to bring together an array of facts as striking as those produced by the evolutionists in favor of their theory, to show that sexual selection is by no means always favorable to the elimination of the chaff, and the preservation of the wheat. A natural attraction, independent of strength or beauty, is an unquestionable element in this problem, and its action is seen among animals as well as among men. The fact that fine progeny are not infrequently the offspring of weak parents, and *vice versâ*, points, perhaps, to some innate power of redress by which the caprices of choice are counterbalanced. But there can be no doubt that types are as often endangered as protected by the so-called law of sexual selection."

"As to the influence of climate and physical conditions," he continues, "we all know

their power for evil and for good upon living beings. But there is, nevertheless, nothing more striking in the whole book of nature than the power shown by types and species to resist physical conditions. Endless evidence may be brought from the whole expanse of land and air and water, showing that identical physical conditions will do nothing toward the merging of species into one another, neither will variety of conditions do anything toward their multiplication. One thing only we know absolutely, and in this treacherous, marshy ground of hypothesis and assumption, it is pleasant to plant one's foot occasionally upon a solid fact here and there. Whatever be the means of preserving and transmitting properties, the primitive types have remained permanent and unchanged, — in the long succession of ages, amid all the appearance and disappearance of kinds, the fading away of one species and the coming in of another, — from the earliest geological periods to the present day. How these types were first introduced, how the species which have successively represented them have replaced one another, — these are the vital questions to which no answer has been given. We are as far from any satisfactory solution of this problem as

if development theories had never been discussed."

In conclusion, he sketches the plan of these articles. "I hope in future articles to show, first, that, however broken the geological record may be, there is a complete sequence in many parts of it, from which the character of the succession may be ascertained; secondly, that, since the most exquisitely delicate structures, as well as embryonic phases of growth of the most perishable nature, have been preserved from very early deposits, we have no right to infer the disappearance of types because their absence disproves some favorite theory; and, lastly, that there is no evidence of a direct descent of later from earlier species in the geological succession of animals"

This paper contained the sentence so often quoted since, "A physical fact is as sacred as a moral principle. Our own nature demands from us this double allegiance." This expressed the secret of his whole life. Every fact in nature was sacred to him, as part of an intellectual conception expressed in the history of the earth and the beings living upon it.

On the 2d of December, he was called to a meeting of the Massachusetts Board of

Agriculture at Fitchburg, where he lectured in the evening on "The structural growth of domesticated animals." Those who accompanied him, and knew the mental and physical depression which had hung about him for weeks, could not see him take his place on the platform, without anxiety. And yet, when he turned to the blackboard, and, with a single sweep of the chalk, drew the faultless outline of an egg, it seemed impossible that anything could be amiss with the hand or the brain that were so steady and so clear.

The end, nevertheless, was very near. Although he dined with friends the next day, and was present at a family festival that week, he spoke of a dimness of sight, and of feeling "strangely asleep." On the 6th he returned early from the Museum, complaining of great weariness, and from that time he never left his room. Attended in his illness by his friends, Dr. Brown-Sequard and Dr. Morrill Wyman, and surrounded by his family, the closing week of his life was undisturbed by acute suffering and full of domestic happiness. Even the voices of his brother and sisters were not wholly silent, for the wires that thrill with so many human interests brought their message of greeting and farewell across

the ocean to his bedside. The thoughts and aims for which he had lived were often on his lips, but the affections were more vivid than the intellect in these last hours. The end came very peacefully, on the 14th of December, 1873. He lies buried at Mount Auburn. The boulder that makes his monument came from the glacier of the Aar, not far from the spot where his hut once stood; and the pine-trees which are fast growing up to shelter it were sent by loving hands from his old home in Switzerland. The land of his birth and the land of his adoption are united in his grave.

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